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Report 2009

EIGHT-INCH FLOATING-HOSELINE SYSTEM FOR SHIP-TO-SHORE FUEL DELIVERY

by

Henry C. Mayo

June 1971

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U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

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Report 2009

EIGHT-INCH FLOATING-HOSELINE SYSTEM

FOR SHIP-TO-SHORE FUEL DELIVERY

Task 1J664717DL4101

June 1971

Distributed by

The Commanding Officer
U. S. Army Mobility Equipment Research and Development Center

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UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Fuels Handling Equipment Division, Mechanical Technology Dept. U. S. Army Mobility Equipment Research and Development Center Fort Belvoir, Virginia	2a. REPORT SECURITY CLASSIFICATION Unclassified
	2b. GROUP

3. REPORT TITLE

EIGHT-INCH FLOATING-HOSELINE SYSTEM FOR SHIP-TO-SHORE FUEL DELIVERY

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Final

5. AUTHOR(S) (First name, middle initial, last name)

Henry C. Mayo

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
June 1971	94	6

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO.	2009
c. Task 1J664717DL4101	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d.	

10. DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	USAMERDC Fort Belvoir, Virginia

13. ABSTRACT

USAMERDC has designed, fabricated, and tested an 8-inch floating hoseline system for ship-to-shore bulk fuel delivery in tactical or amphibious-assault-type operations. Part of the development effort was accomplished by Flight Refueling, Inc. ~~(later renamed Allied Research Associates, Inc.), under Contract DA-44-009-AMC-92(T)~~ and by the United States Rubber Co. ~~(later renamed Uniroyal, Inc.) under Contract DA-44-009-AMC-1690(T).~~

The developed system comprises a hose-reeling unit anchored on the beach; up to 1000 feet of flexible, 8-inch-diameter, floating hoseline; tension cable for the hoseline; a conventional four-legged mooring offshore; and hoseline purging equipment.

The normal operational procedure is to tow the tension cable (two parts) with a workboat from the beach to the moored vessel, power the hoseline from the beach to the vessel with the reeling unit and the tension cable, discahrge the fuel through the hoseline from the vessel to onshore storage, eliminate the residual fuel from the hoseline with the purging equipment, and then recover the hoseline and tension cable with the reeling unit. The system is designed for complete installation within 4 hours and for a fuel delivery rate of 1050 gpm at 100 psi.

The report concludes that:

a. The system is satisfactory for installing, operating, and recovering up to 1000 feet of 8-inch-diameter floating hoseline under sea conditions permitting a tactical or amphibious assault operation.

b. The system should be satisfactory for military operations in which air transportability is required.

DD FORM 1 NOV 65 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

UNCLASSIFIED
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Hose Hoseline Fuel Offloading Marine Terminals Offshore Construction Tactical Amphibious Fueling Ship-to-shore Floating hoseline						

1-2-3-4 —33,519—Ft Belvoir

SUMMARY

The U. S. Army Mobility Equipment Research and Development Center (USAMERDC) has designed, fabricated, and tested an 8-inch floating-hoseline system for ship-to-shore bulk fuel delivery in tactical or amphibious-assault-type operations. Part of the development effort was accomplished by Flight Refueling, Inc. (later renamed Allied Research Associates, Inc.), under Contract DA-44-009-AMC-92(T) and by the United States Rubber Co. (later renamed Uniroyal, Inc.) under Contract DA-44-009-AMC-1690(T).

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FOREWORD

Authority for the development and testing of an 8-inch floating-hoseline system for ship-to-shore fuel delivery is contained in Task 1J664717DL4101, "Tanker, Marine Terminal Systems."

Work on the development and testing of the system was accomplished at USAMERDC under the direction of C. W. Karstens, former Chief, Fuels Handling Equipment Division, Mechanical Technology Laboratory, and, subsequently, under the direction of J. D. Grabski, present Chief of the Division.

The work was conducted during the period of January 1960 to June 1970.

The following USAMERDC personnel actively engaged in work on the project:

a. **Construction and Marine Systems Branch**

Taylor H. Jefferson, former Branch Chief
John A. Christians, former Branch Chief
Joseph Cloyd, former Project Engineer
Henry C. Mayo, Project Engineer
Marion Bartoszyk, former Project Engineer
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William Stoney
John Haugh
William Johnston
Conrad Korzendorfer
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EIGHT-INCH FLOATING-HOSELINE SYSTEM

FOR SHIP-TO-SHORE FUEL DELIVERY

I. INTRODUCTION

1. **Subject.** This report describes and discusses the development of an 8-inch floating-hoseline system for delivering bulk fuel from a moored barge or small tanker to onshore storage facilities in tactical situations. The system comprises a hose-reeling unit anchored on the beach; up to 1000 feet of flexible, 8-inch-diameter, floating hoseline; tension cable (wire rope) for the hoseline; a conventional four-legged offshore mooring; and hoseline purging equipment. The normal operational procedure is to tow the tension cable (two parts) with a workboat, from the beach to the moored vessel, power the hoseline from the beach to the vessel with the reeling unit and the tension cable, discharge the fuel through the hoseline from the vessel to onshore storage, purge the hoseline, and then recover the hoseline and tension line with the reeling unit. This procedure keeps the hoseline out of the way of local boat traffic during periods when fuel offloading is not being conducted. The system is designed for complete installation in 4 hours and for a fuel delivery rate of 1050 gpm at 100 psi. The system is illustrated in Fig. 1.

2. **Background.** The most common means for offloading bulk transport vessels when permanent docking facilities are not available involves the use of a conventional submarine pipeline system. Such pipeline systems generally require extensive construction effort in terms of manhours, equipment, and logistical tonnage. Further, the fuel requirements established by the Army[1] can be met only through the development of improved systems and concepts for offloading large quantities of bulk fuel from vessels at offshore mooring sites to onshore storage facilities. The area where improvement is most needed is in systems for tactical use, where the equipment must be quickly and easily installable, versatile, lightweight (air transportable if possible), economical, and dependable.

The development of the 8-inch floating-hoseline system was initiated in order to provide a system for improved fuel delivery techniques and to increase the Army's capability for supplying and distributing fuel at any time, on short notice, and in tactical situations.

[1]U. S. Army Quartermaster Board, "Petroleum Supply for the Army in the Field (U)," Fort Lee, Virginia, May 1960.

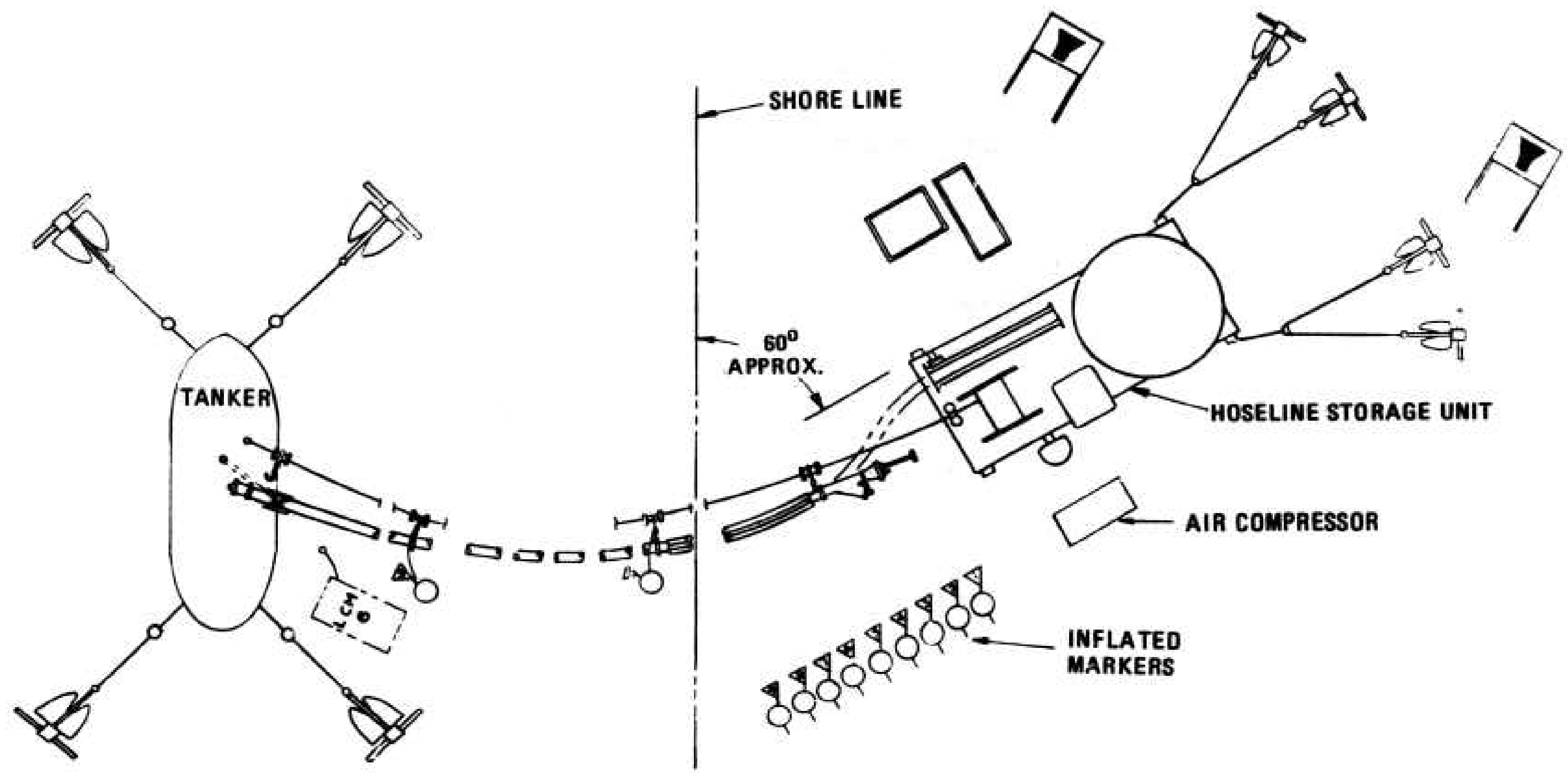

Fig. 1. Concept diagram of floating-hoseline system.

II. INVESTIGATION

3. **Requirements.** The specific requirements against which the development of the 8-inch floating-hoseline system was conducted are derived from a draft Army Small Development Requirement (SDR) dated 6 September 1966. The SDR was drafted by the U. S. Army Combat Developments Command Engineer Agency (USACDCEA), Fort Belvoir, Virginia (USAMERDC submitted material for use in the USACDCEA draft document on 28 October 1963). The following are essential characteristics of the hoseline system:

a. Be capable of transferring high (40-percent) aromatic hydrocarbon fuels at a flow rate of 1500 barrels per hour at 100 psi pressure.

b. Be capable of being installed and operational in 4 hours or less under various conditions within a temperature range of 25° F to 125° F (operation is desired under conditions permitting an amphibious landing, including a 4-foot surf and 3-knot current).

c. The system shall be capable of being extended to a length of 1000 feet.

d. The hose shall be fabricated from materials resistant to all types of military hydrocarbon fuels and shall not adversely affect the quality of the fuel.

e. The hose and restraining cable shall have sufficient tensile strength to withstand the stresses caused by current and wave action.

f. The system shall have a service life of 6 months and a minimum shelf life of 3 years. Storage shall be under cover with ambient temperature range from -25° F to 125° F.

g. The system shall be capable of being installed with equipment, TO&E, and Class IV normally available to appropriate Engineer and Transportation TO&E units.

h. The hose shall be flexible and lightweight, with maximum weight of 8 pounds per foot. Maximum weight of 5 pounds per foot is desirable. Collapsible capability is desired.

i. The system shall be capable of withstanding field service conditions normally encountered during an amphibious landing operation.

j. The power source will be a standard military engine and shall be designed for the elimination of interference with radio communications.

k. The hose shall not elongate, contract, or twist in such a manner as to impair function of the system.

l. The system shall be capable of being transported by highway, rail, and sea.

m. The overall dimensions of system components shall not exceed the allowable limits of the Berne International Clearance Diagram.

n. The hose shall withstand 200 psig proof pressure and have a minimum burst pressure of 300 psig.

4. Description.

a. **General.** The 8-inch floating-hoseline system is used to transfer petroleum products from bulk fuel cargo vessels to onshore storage tanks.[2] It comprises an 8-inch floating hoseline, hose-reeling unit, four-legged mooring system, and hoseline purging system. It is designed for operation with as much as 1000 feet of hoseline. The reeling unit has storage capacity for 500 feet of hoseline. The remaining 500 feet of hoseline, if required, are faked on the beach near the reeling unit. Tabulated data for the system components is presented in Appendix A.

b. **Floating Hoseline.** The floating hoseline (Fig. 2) is used as a connection between the vessel's manifold and the onshore storage tanks. Each hose section is 50 feet long. The hose sections are coupled together with aluminum Victaulic couplings into 250-foot lengths of hoseline for storage on the reeling unit. Eyes are provided on the nipples to allow the hose to be connected to a tension cable. The tension cable is used to relieve tensile forces from the hoseline while the hoseline is deployed. Inflatable marker buoys are connected at alternate hoseline joints to provide visual marking of the location of the hoseline while it is in the water. The hose weighs 7.8 pounds per foot, including fittings, and is self-floating, either empty or full of fuel. The purchase description for the hose is presented in Appendix B. Additional description is included in paragraph 6b.

c. **Hose-Reeling Unit.** The reeling unit (Fig. 3) is used for storage of 500 feet of hoseline, installation of as much as 1000 feet of hoseline, and recovery of the hoseline. It is hydraulically operated by two men. It is constructed of a steel skidbase and reinforcing members. The following components are fitted on the skidbase:

---

[2] U. S. Army Mobility Equipment Command, "Operator, Organizational, Direct and General Support Maintenance Manual for Floating Hoseline System, 8-Inch," DTM-5-3835-208-14, St. Louis, Missouri, April 1968.

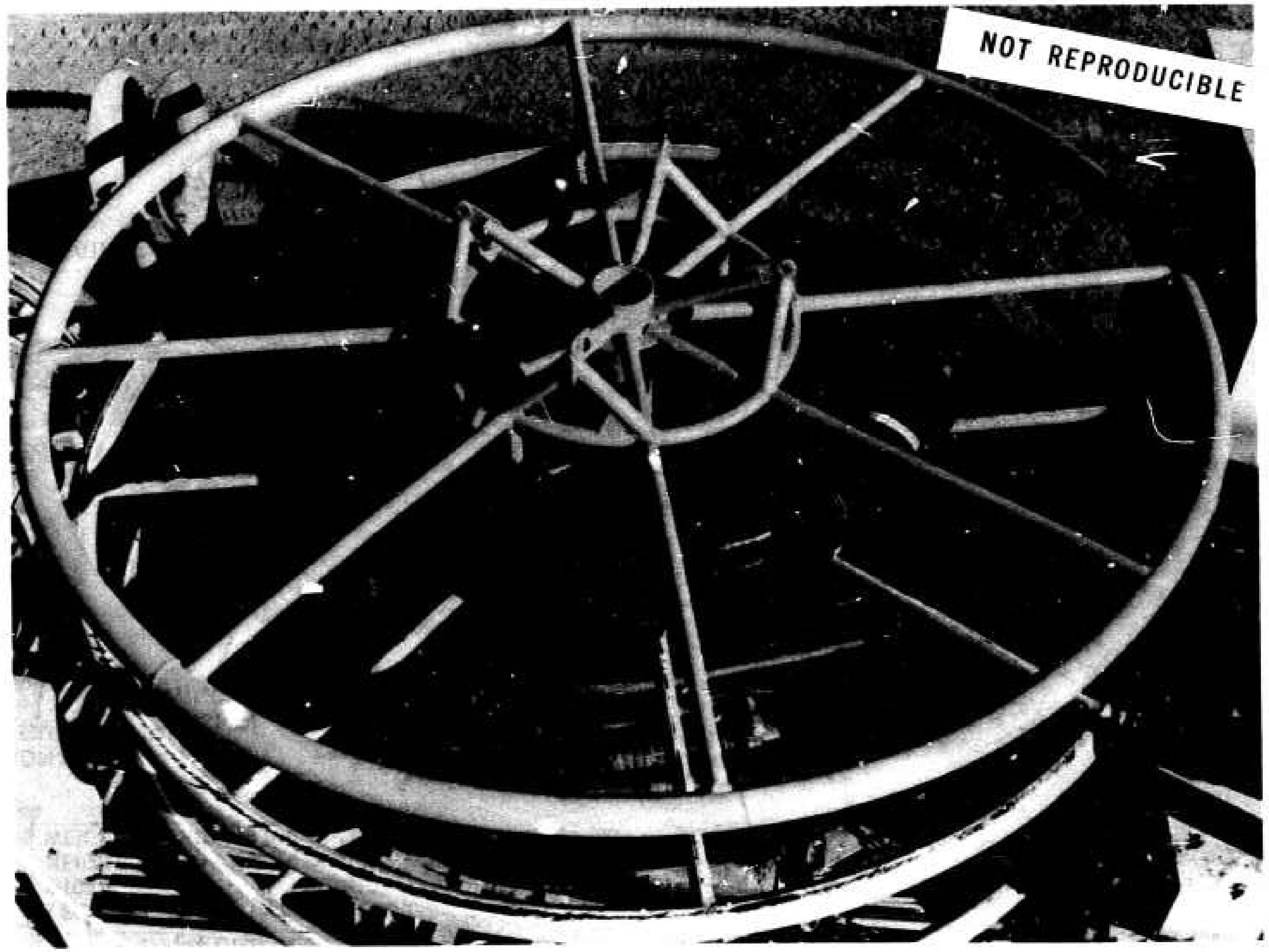

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Fig. 2. Floating hoseline on reeling unit.

SHIPPING DIMENSIONS	
LENGTH	240 INCHES
WIDTH	121 INCHES
HEIGHT	78 INCHES
WEIGHT (APPROX)	9,000 POUNDS

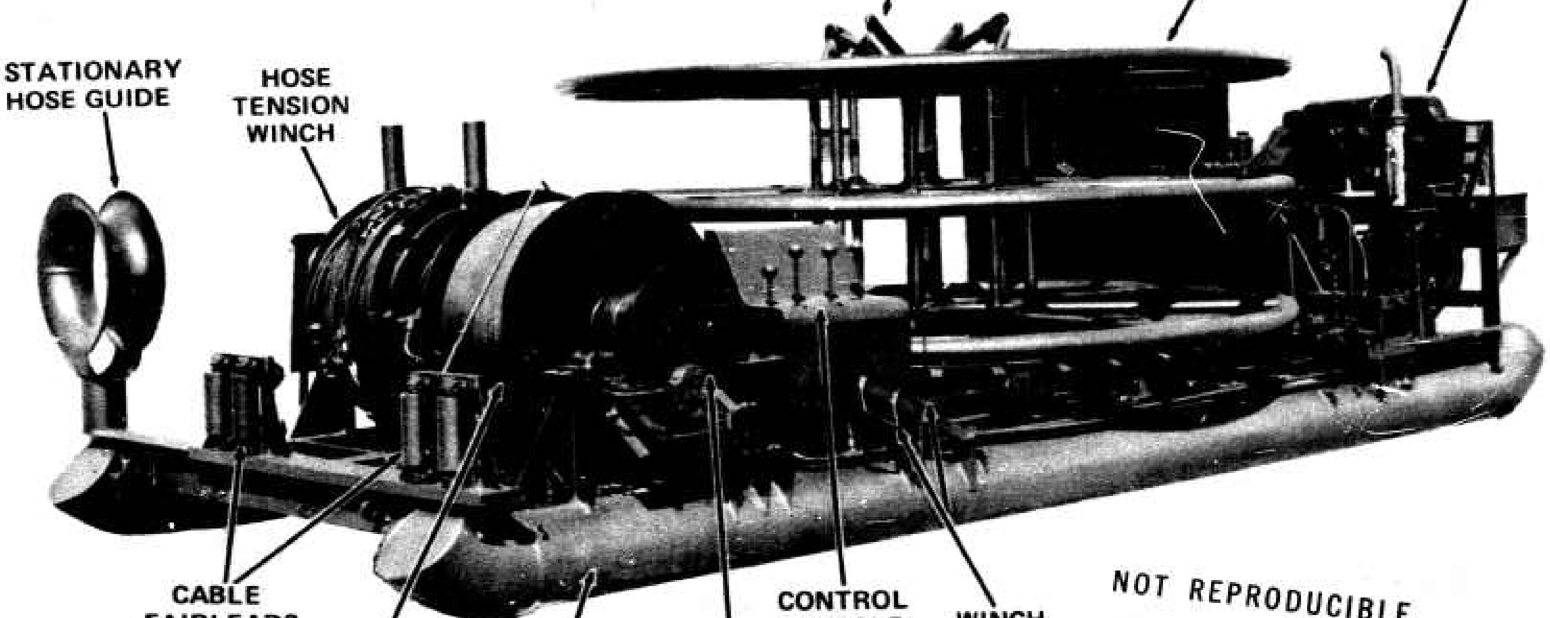

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Fig. 3. Hose-reeling unit.

(1) **Engine.** Power for operation of the winch hydraulic pump and the reel hydraulic pump is provided by a 20-horsepower, military standard model, air-cooled gasoline engine.

(2) **Hydraulic System.** The hydraulic system has an operating pressure of 1500 psi and contains two 45-gpm pumps used for the winch motors. A 12-gpm pump is used for the hose-reel motor, which drives the hose reel through a "Harmonic Drive" (United Shoe Machinery Corp. and a coated wire rope (see paragraph 4c(4)). Two hydraulic winch motors, which power the drums through "Harmonic Drive" speed reducers, are mounted inside the winch drums (the output shafts are locked and the speed reducer case drives the drum). A hydraulic cylinder moves the winch fairleaders back and forth. Hydraulic controls are provided for operating each winch, the hose reel, and the fairleaders (Fig. 4). A telltale filter, discharge filter, hydraulic tank, check valves, relief valves, lines, and fittings complete the system. (See Fig. 5 for hydraulic system schematic.)

(3) **Stowage Box.** The stowage box, mounted adjacent to the engine, is used to stow marker buoys, couplings, purging fittings, and other supplemental equipment.

(4) **Hose Reel.** The reel (Fig. 2) is a single weldment with sufficient storage capacity for 500 feet of 8-inch hoseline. It has four lifting eyes. It rides on six roller bearing casters and is aligned by five side rollers. It is driven by a nylon-coated, continuous, wire-rope riding in a V-groove on the lower perimeter of the reel.

(5) **Control Console.** The control console (Fig. 4) contains the necessary levers and valves to control the operation of the hose reel, winches, and fairleaders.

(6) **Winches.** There are two winches on the unit. Both are driven by hydraulic motors through "Harmonic Drive" speed reducers mounted inside the drums. They are designed for a maximum pull of 10,000 pounds. The winches have the following additional features:

(a) Each winch has its own pawl, which is engaged after the hose has been installed to relieve the force on the hydraulic system. The pawls are engaged or disengaged by levers mounted immediately adjacent to the control console.

(b) Each winch has a locking mechanism on the output shaft of the speed reducers. The locking mechanism is engaged when powering the winch, either in or out. When freewheeling the winch (taking cable off the

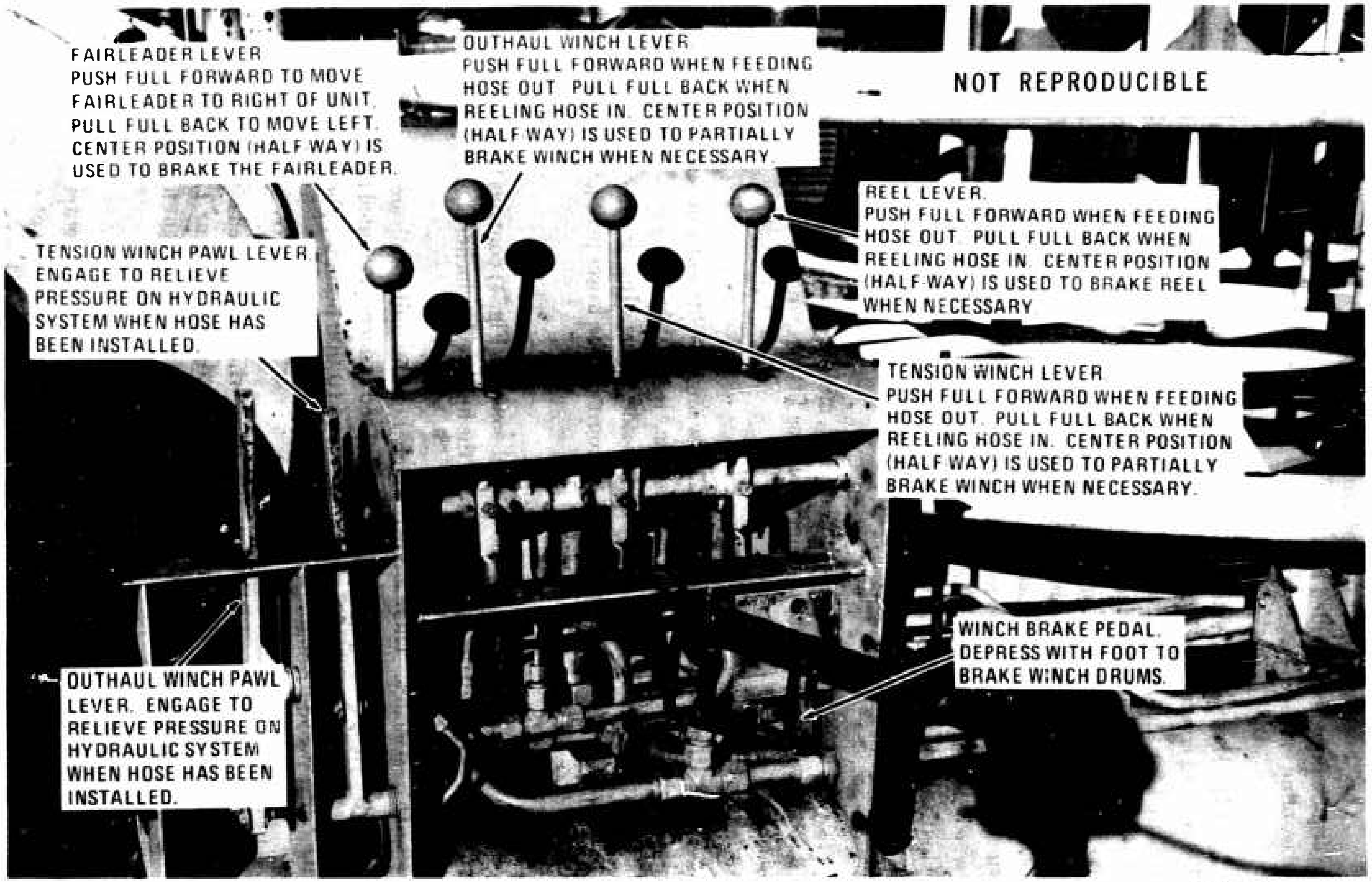

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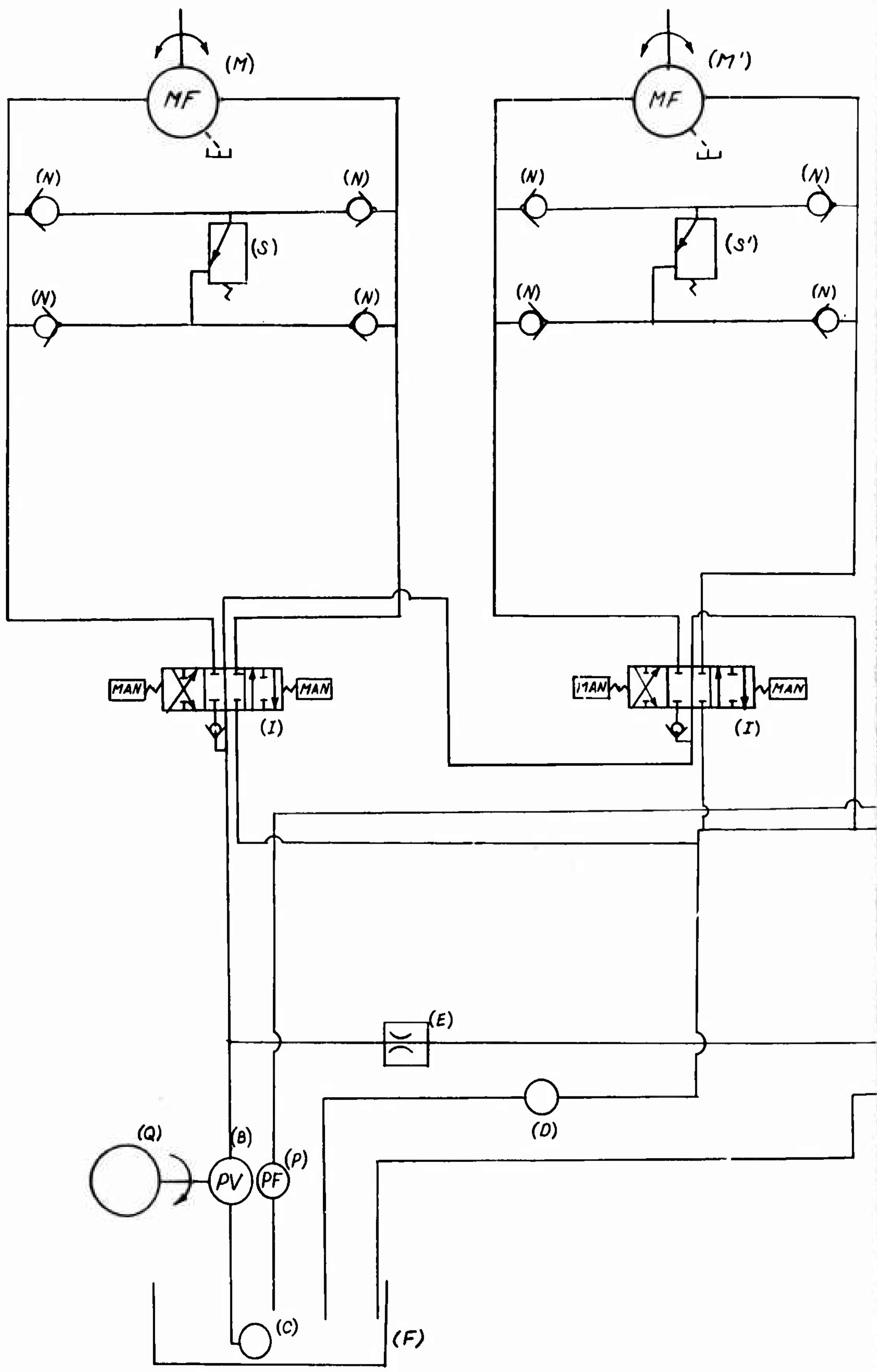
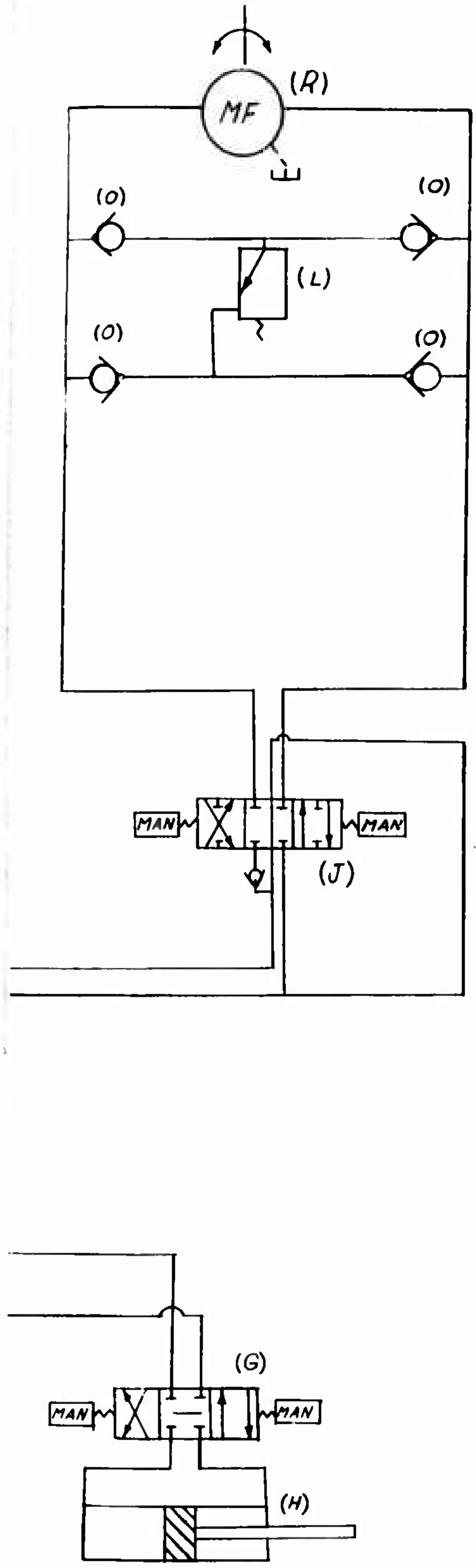
Fig. 4. Controls on reeling unit.

A



B



KEY	NO. REQ	IDENTIFICATION
(B)	1	PISTON PUMP (WINCH)
(C)	1	INLET FILTER (TELL TALE)
(D)	1	INLET FILTER
(E)	1	FLOW CONTROL
(F)	1	HYDRAULIC TANK
(G)	1	DIRECTIONAL VALVE (FAIRLEADER)
(H)	1	CYLINDER (FAIRLEADER)
(I)	2	DIRECTIONAL VALVE (WINCH)
(J)	1	DIRECTIONAL VALVE (REEL)
(L)	1	RELIEF VALVE
(M)	2	FLUID MOTOR (WINCH)
(N)	8	CHECK VALVE
(O)	4	CHECK VALVE
(P)	1	VANE PUMP (REEL)
(Q)	1	ENGINE
(R)	1	FLUID MOTOR (REEL)
(S)	2	RELIEF VALVE

Fig. 5. Hydraulic schematic.

winch drums, as opposed to powering the winch in reverse) the locking mechanism must be disengaged.

(c) Each winch has a hydraulically operated (via foot pedal and brake cylinder) caliper disc brake. A single brake pedal controls both brakes. When the output shaft is unlocked (winch drum in freewheeling mode), the disc brake controls the rotating speed of the winch.

(d) The hose-tension winch, mounted near the hose guides, contains 1500 feet of 5/8-inch hose-tension cable (wire rope). Clamps are mounted at approximately every 49 feet on the cable and serve as the connection places for the hoseline. A three-way hook-swivel assembly is used. One hook connects to an eye on the hose nipple, the second hook connects to the tension cable at the cable-clamp location, and the third to a plastic marker buoy (at alternate cable-clamp locations).

(e) The outhaul winch, mounted near the control console, contains 2500 feet of ½-inch outhaul cable. It is used to pull the floating hoseline and tension cable to the moored cargo vessel.

(7) **Hose Guides.** The hose guides (Figs. 2 and 3) are used for guiding the hoseline off of and onto the reel. The forward guide is fixed. The rear guide is adjustable and is locked in place by two pins.

(8) **Fairleader.** Each fairleader (Fig. 3) consists of a double set of roller guides to help spool the cable on the winches. Its motion is hydraulically controlled from the control console.

d. **Mooring.** The mooring comprises four mooring legs (Fig. 6). Each leg consists of a 2000-pound LWT anchor, three lengths (270 feet each) of 1-inch chain, and a mooring buoy. At a location about 10 feet below the buoy in each leg, a 3/4-inch chain (one 90-foot length) is connected between the 1-inch chain and a 100-pound LWT anchor. This small anchor is used to keep the buoy in place while the mooring is not in use. The mooring leg assembly is stored in a 6- by 4- by 1½-foot fabricated steel box with an open top.

A marker buoy assembly is used to mark the location of each mooring leg prior to mooring-leg installation. The assembly consists of a 50-pound weight, a plastic buoy, and rope riser line of appropriate length (see Fig. 7).

A 4-inch-circumference nylon hawser is used to connect each mooring leg to the cargo vessel.

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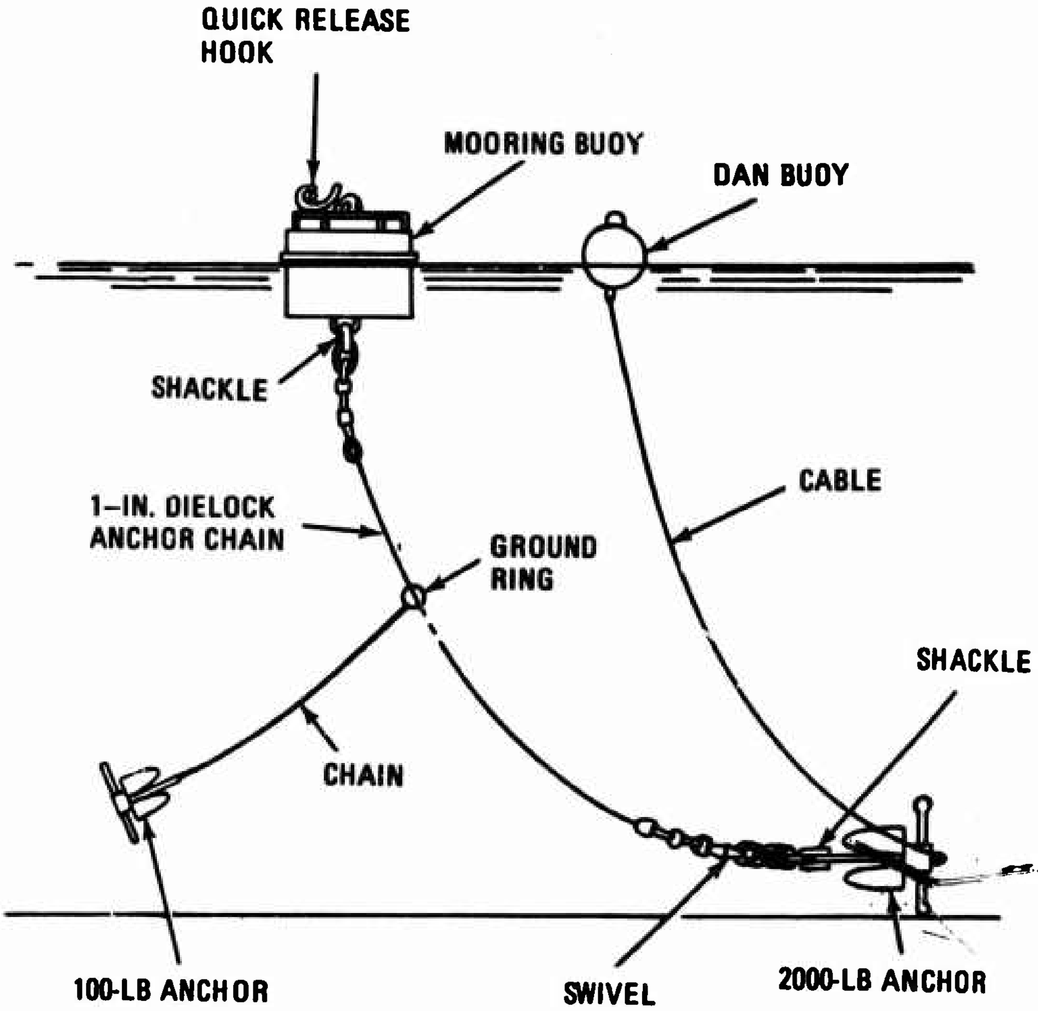


Fig. 6. Mooring leg.

e. **Purging Equipment.** Purging equipment (Fig. 8) is furnished to evacuate fuel from the hoseline after unloading operations. Its operation consists of forcing a purging sphere through the hoseline from shore to the cargo vessel, thereby displacing the fuel in the hoseline back into the vessel.

(1) **Purging Sphere.** The purging sphere is an inflatable, hard-rubber ball of nominal 8-inch diameter. Inflation of the sphere is adjusted to effect a seal between the sphere and the hose bore. Adjustment is necessary to compensate for various operating pressures that may be encountered.

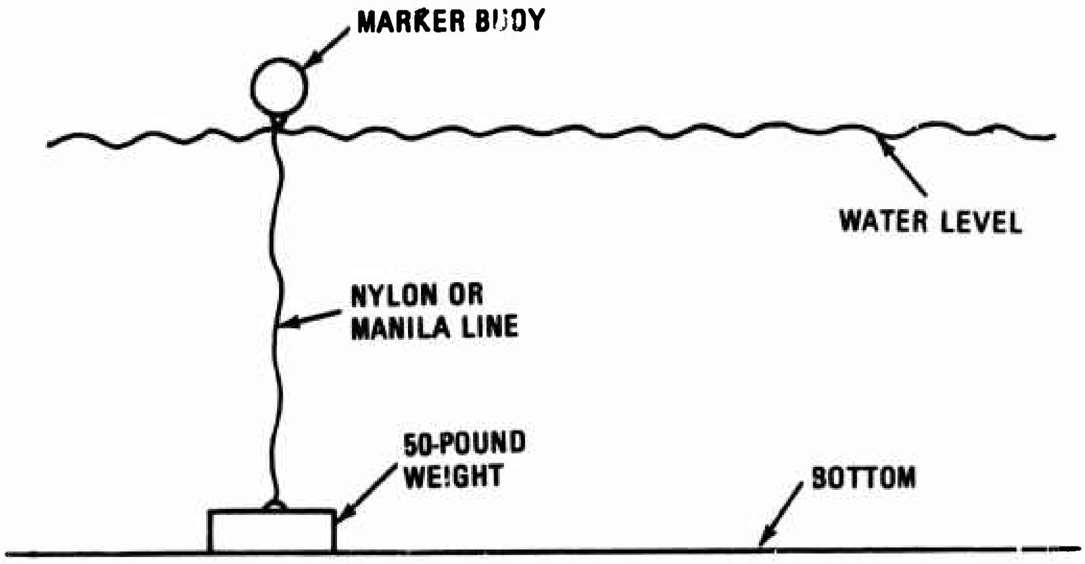


Fig. 7. Marker buoy assembly for mooring legs.

(2) **Purging Fittings.** The purging sphere is normally retained in a purging lateral (a Y-shaped fitting) at the onshore end of the hoseline where the connection is made to the fuel storage tank manifolds. The purging lateral is equipped with a pusher rod that allows the purging sphere to be manually injected into the hose when purging operations are begun. Compressed air, which is added to the purging lateral through an air valve, propels the purging sphere through the hoseline. A purging nipple located on the cargo-vessel end of the hoseline traps the purging sphere after the fuel has been expelled from the hose. The sphere is removed from the fitting by uncoupling the empty hose.

(3) **Air Compressor.** The compressed air required for the hoseline purging operations is provided by an engine-driven air compressor with a rating of 55 cfm at 80 psi. Purging air requirements are approximately 30 cfm at 40 psig, minimum.

f. **Sling-Trough Assembly.** A trough and sling assembly may be used to protect the floating hose from scuffing on the gunwales of the cargo vessel during fuel-transfer operations.

g. **Manifold Adapters.** To insure proper mating of connections to the cargo-vessel manifolds, a set of 6-inch, 8-inch, and 10-inch grooved pipe reducers and couplings are included in the system.

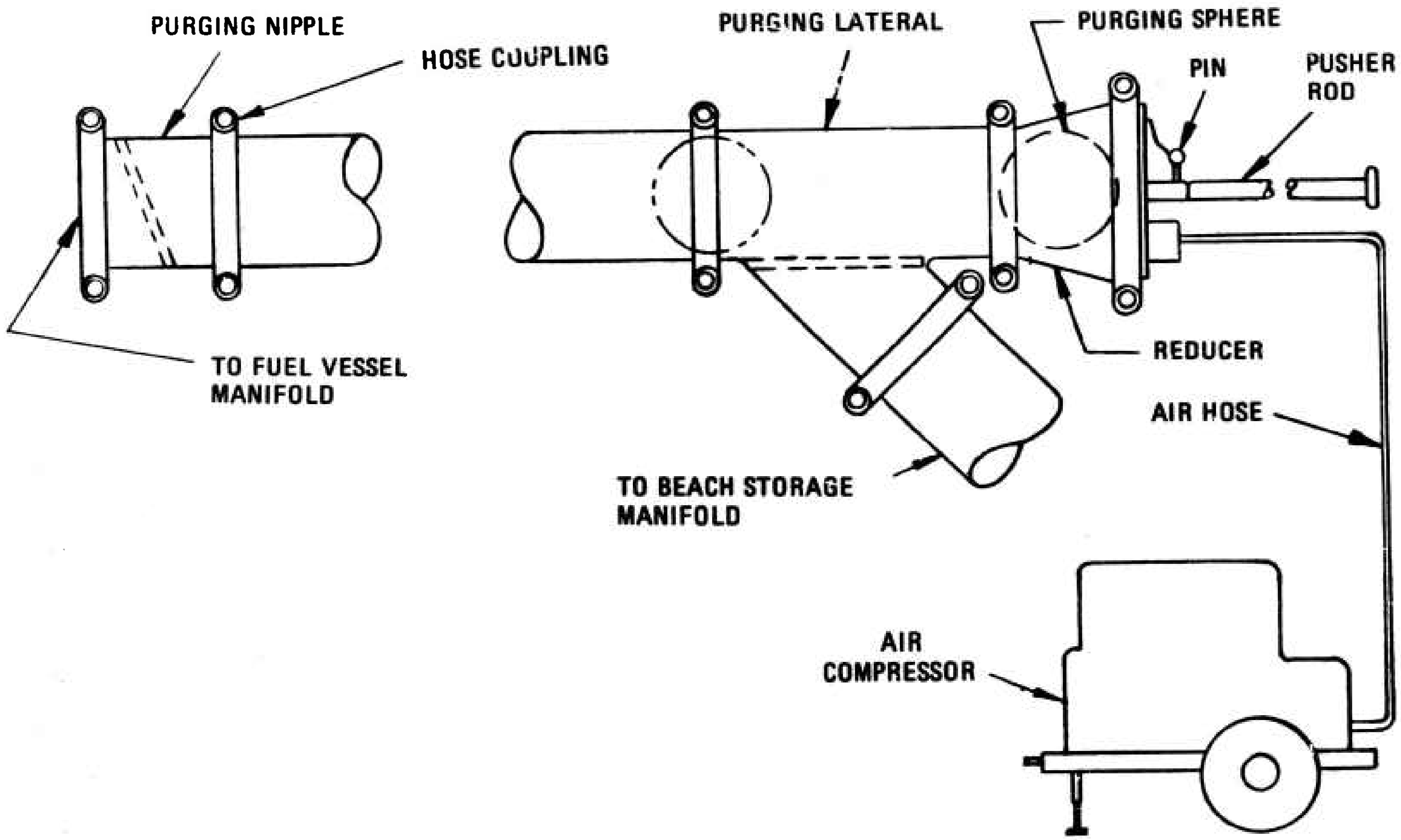


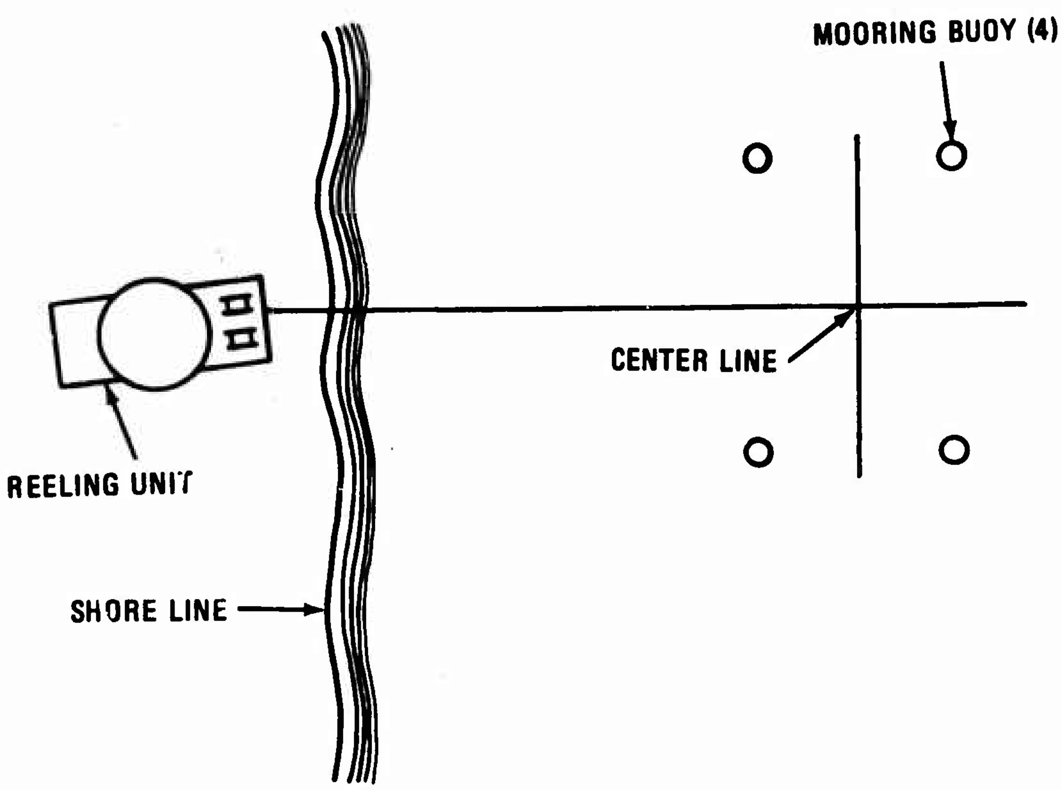
Fig. 8. Purging equipment.

5. **Installation and System Operation.**

a. **Installation.**

(1) **Reeling Unit.** The reeling unit is initially positioned on the beach about 80 feet beyond the high water mark on the centerline of the mooring, using a crawler tractor (D-7 Size). The winches on the reeling unit are headed offshore (refer to Fig. 9). The reeling unit is secured on the beach with the 750-pound LWT anchor (Fig. 10). The anchor is set by dragging the reeling unit, with anchor attached, toward the waterline for about 50 feet. The reeling unit should finally be secured at a location about 20 to 30 feet toward shore from the high water mark.

(2) **Mooring.** The mooring area is surveyed with a lead line or fathometer to determine water depth data. Local charts, if available, should also be used. The location of the mooring must be within 900 feet of the beach if 1000 feet of



NOTE: POSITION UNIT 20 TO 30 FEET BEYOND HIGH WATER MARK.

Fig. 9. Positioning reeling unit.

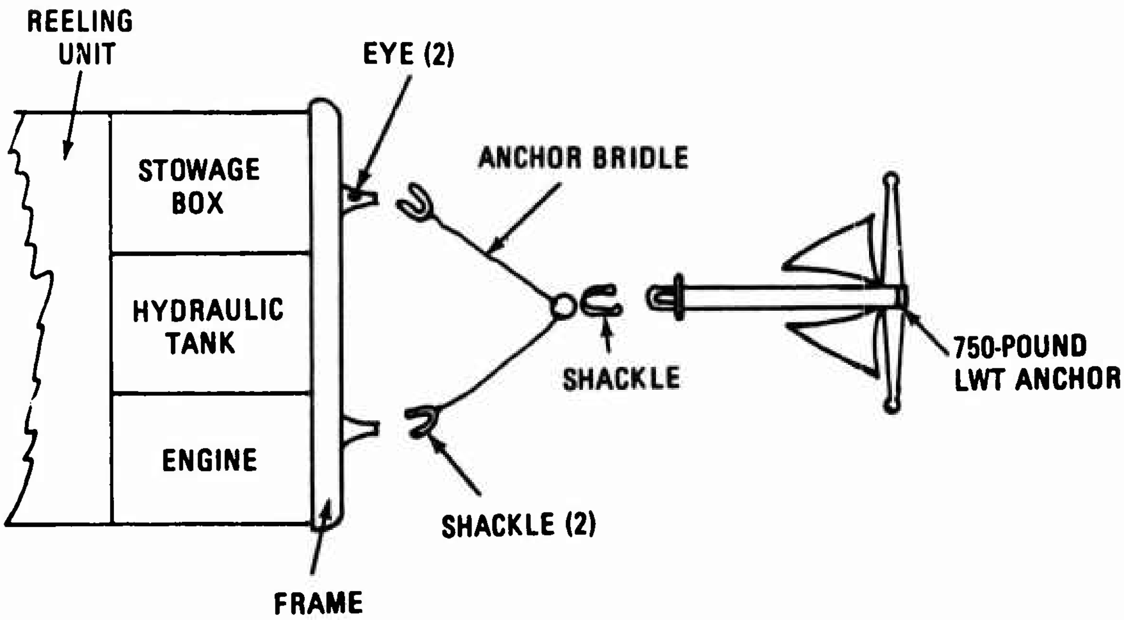


Fig. 10. Securing the reeling unit.

the hoseline are to be used. The water depth at the mooring must be sufficient for the type of vessels to be offloaded.

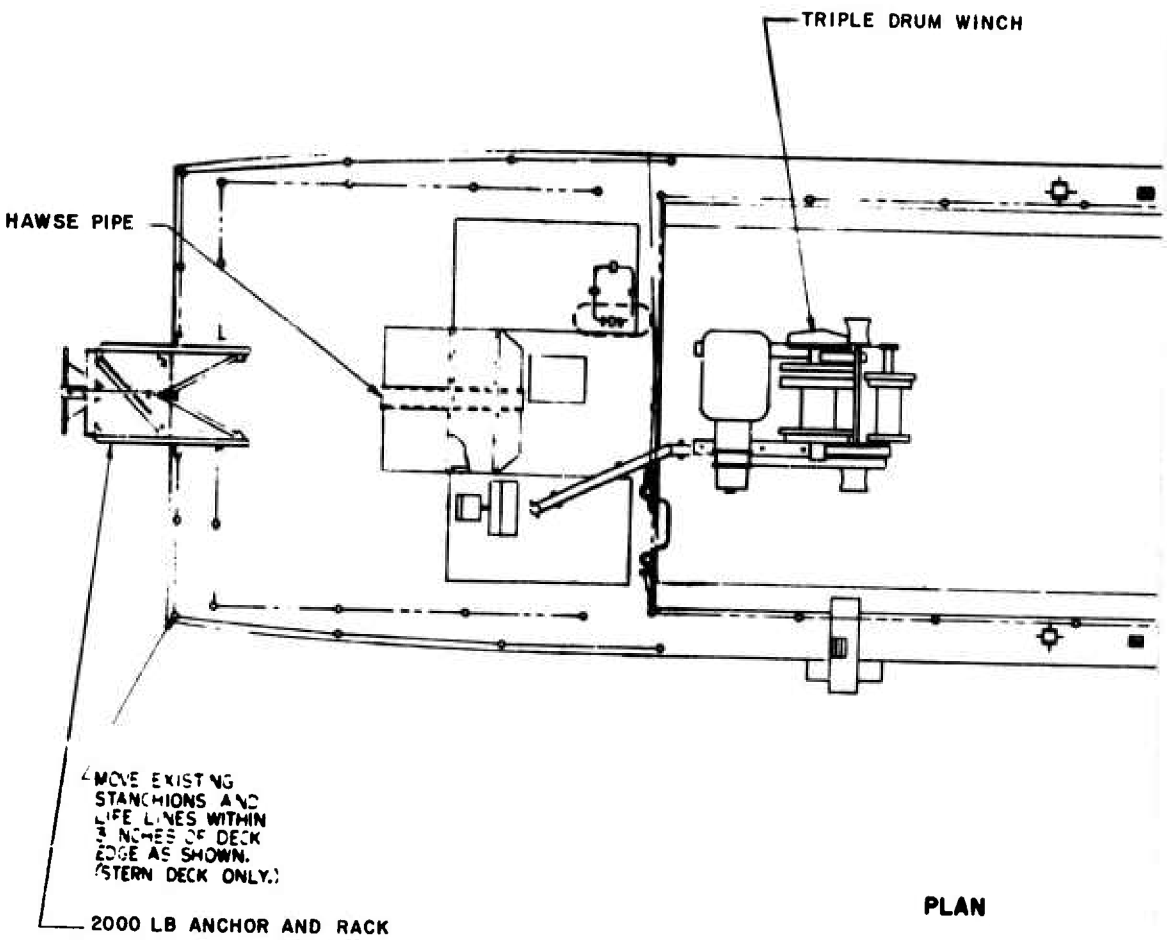
Marker buoys (Fig. 7) are installed to mark the location of each of the four mooring legs. The marker buoys are installed by setting up a baseline on shore and then using two transits to guide a workboat to the correct site for dropping the marker buoys.

The four mooring legs are then installed (Fig. 6). A barge (an LCM-8 warping tug—modified landing craft mechanized, as in Fig. 11) or landing craft utility (LCU) may be used as the installing vessel. When LCM-8 tug is used, each mooring leg is installed at the marked location, as follows:

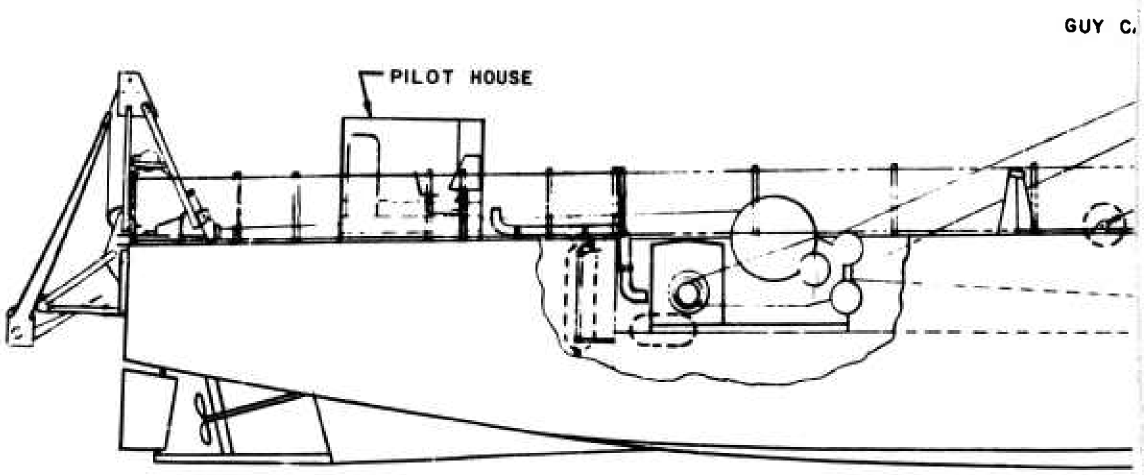
(a) Lower the stern anchor of the tug near the center of the mooring site. Then head toward the first marker buoy.

(b) When the bow of the tug reaches the marker buoy, use the A-frame to lift the 2000-pound anchor (with 1-inch chain attached) from the chain storage box placed in the cargo well.

(c) Place the 1-inch chain over the bow of the LCM-8 tug. Lower the anchor to the bottom, using a quick-release hook.



PLAN



ELEVATION

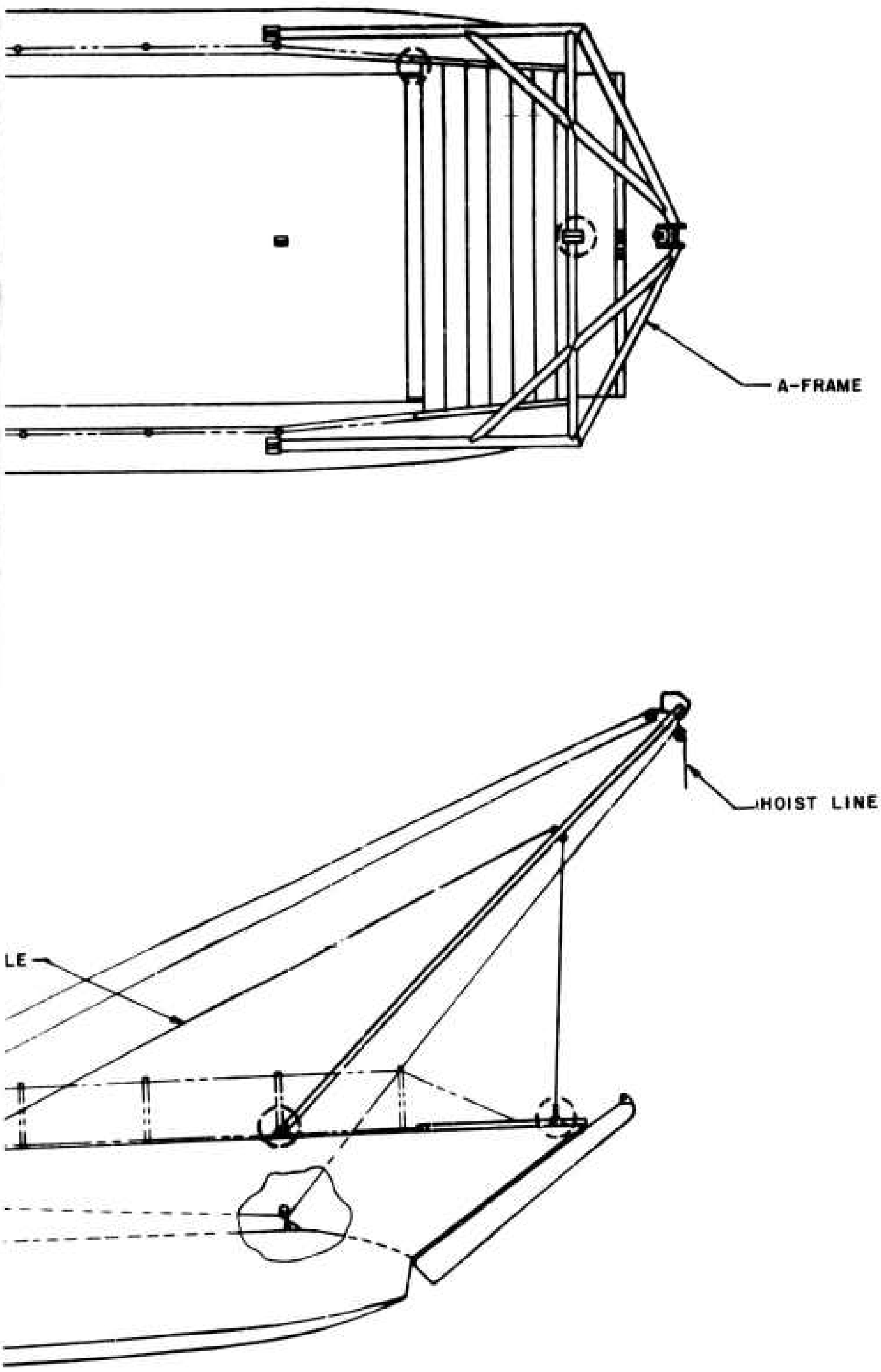


Fig. 11. LCM-8 warping tug.

(d) Recover the quick-release hook from the anchor.

(e) Warp the LCM-8 tug on its stern anchor (toward center of mooring) while paying out the chain over the bow. Take care to lay the chain in a straight line.

(f) After most of the 1-inch chain has been installed and the plate shackle joining the 3/4-inch chain is exposed in the chain box, connect A-frame line and quick-release hook to the mooring buoy. Set the mooring buoy into the water, while keeping the 100-pound LWT anchor aboard. Do not release the buoy.

(g) Back engines of LCM-8 (do not use warping winch) to set the 2000-pound anchor.

(h) Trip the quick-release hook to free the mooring buoy.

(i) Warp the LCM-8 tug toward the center of the mooring while paying out the 3/4-inch chain. Put the 100-pound anchor overboard.

(j) Recover the LCM-8 tug's stern anchor and install the remaining three legs in similar fashion.

The installing procedure, when using an LCU or barge, is basically the same as that for the LCM-8 tug. However, a crane of at least 2 tons capacity must be placed aboard the vessel to perform the function of the A-frame on the LCM-8 tug.

(3) **Connection to Storage Tanks.** A pipe or hose is installed from the manifold of the storage tanks to the vicinity of the reeling unit.

(4) **Purging Equipment.** The system is ready for operation after the purging equipment is set up as follows (refer to Fig. 8):

(a) Locate the air compressor on the right side of the reeling unit facing seaward in a level position with solid footing.

(b) Assure that the leveling jack is down and properly adjusted to level the compressor.

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(c) Block the wheels of the air compressor to prevent movement during operation. If necessary, wet down the surrounding area to keep down the dust.

(d) Remove the purging nipple, the purging sphere, and the purging lateral from the storage container.

(e) Measure the purging sphere, using a steel tape. Inflate the purging sphere until the circumference measures 25¼ inches.

(f) Remove the cap from the purging lateral and insert the purging sphere into the purging lateral.

(g) Reinstall the cap on the purging lateral.

(h) Remove the hose cap from the hoseline end, which is projecting from the hose guide.

(i) Install the purging nipple.

(j) Reinstall the hose cap on the open end of the purging nipple.

b. **Operation.** The operating personnel should have received training in the system operational procedures, particularly the person operating the reeling unit. Successful vessel offloadings are largely dependent on the skill of the operating personnel. Exact operating procedures will vary with the particular installation. The system should be operated as described below:

(1) See that installation of the system components is complete (see paragraph 5a).

(2) Moor the cargo vessel in the four-leg mooring using a workboat to handle the hawsers.

(3) Depending on sea and wind conditions, deliver the 8-inch floating hoseline to the moored cargo vessel by one of the two following methods:

(a) Method for Very Calm Conditions.

1. Using a small boat (such as an Army bridge erection boat) or an amphibian (such as a LARC-5), deliver the necessary reducers and

fittings to the moored vessel. Also deliver the purging nipple and hose trough.

2. Connect the hoseline and hose-tension cable as indicated in Fig. 12.

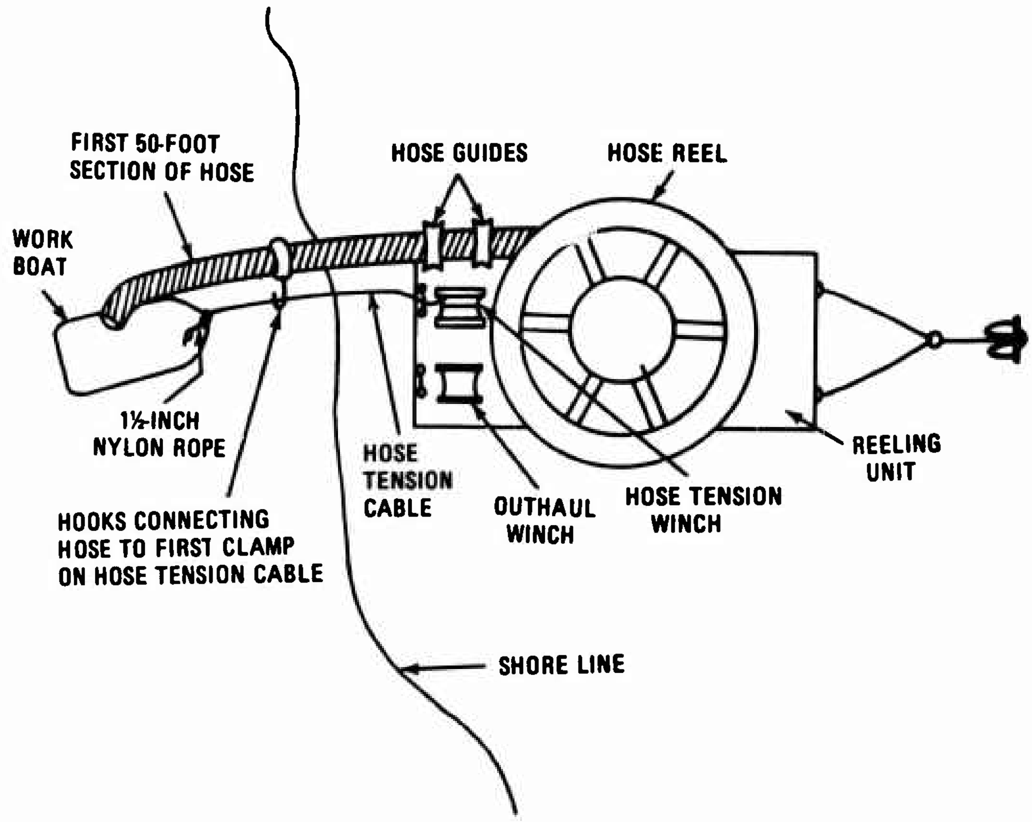

Fig. 12. Connecting hoseline and hose-tension cable.

3. Refer to Fig. 4 for reeling-unit controls. With the workboat, begin to pull the hoseline and hose-tension cable out toward the moored vessel. The hose-tension winch is powered out to provide precise control over the pulling speed. Also power out the hose reel. Regulate the speeds of the hose-tension winch and hose reel to keep all tensile forces in the hose-tension cable, not in the hoseline.

4. Connect the hoseline to the tension cable at 50-foot intervals. The boat can be stopped and held for this hookup by the tension cable.

5. Connect a marker buoy every 100 feet.

6. After one layer of hoseline has been pulled off the reel, stop the boat by means of the winch, and connect the next layer of hoseline.

7. Continue pulling the hoseline and the hose-tension cable out until the workboat is alongside the moored vessel.

8. Pass the first 50-foot hose section aboard the vessel and pass the 1½-inch nylon rope aboard.

9. Secure the 1½-inch nylon rope to a bitt on the barge, secure the hose trough to the vessel's side, remove the blind flange from the hoseline end, and connect the hoseline to the vessel's manifold (Fig. 13).

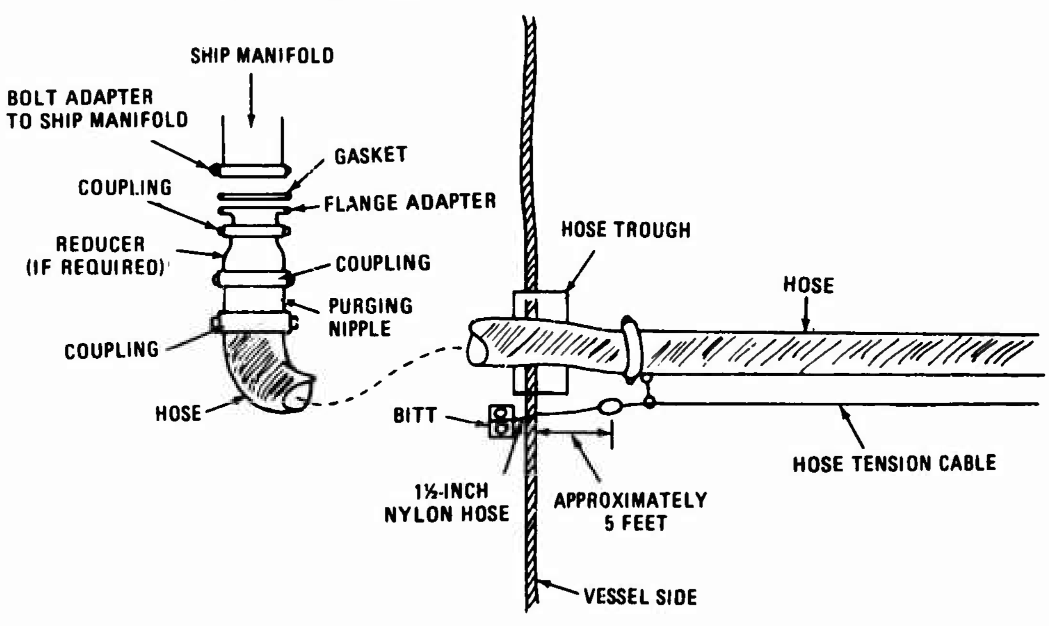

Fig. 13. Connecting hose to manifold.

10. Lock the pawl on the hose-tension winch.

11. Upon signal from shore that hoseline connection is complete, commence offloading.

(b) Normal Method (Rough water, high tidal current, and high wind).

1. Using a workboat or amphibious vehicle, pass aboard the items mentioned in paragraph (a)1 above.

2. Refer to Fig. 14 and connect the outhaul cable (with 1/2-inch diameter) to the workboat.

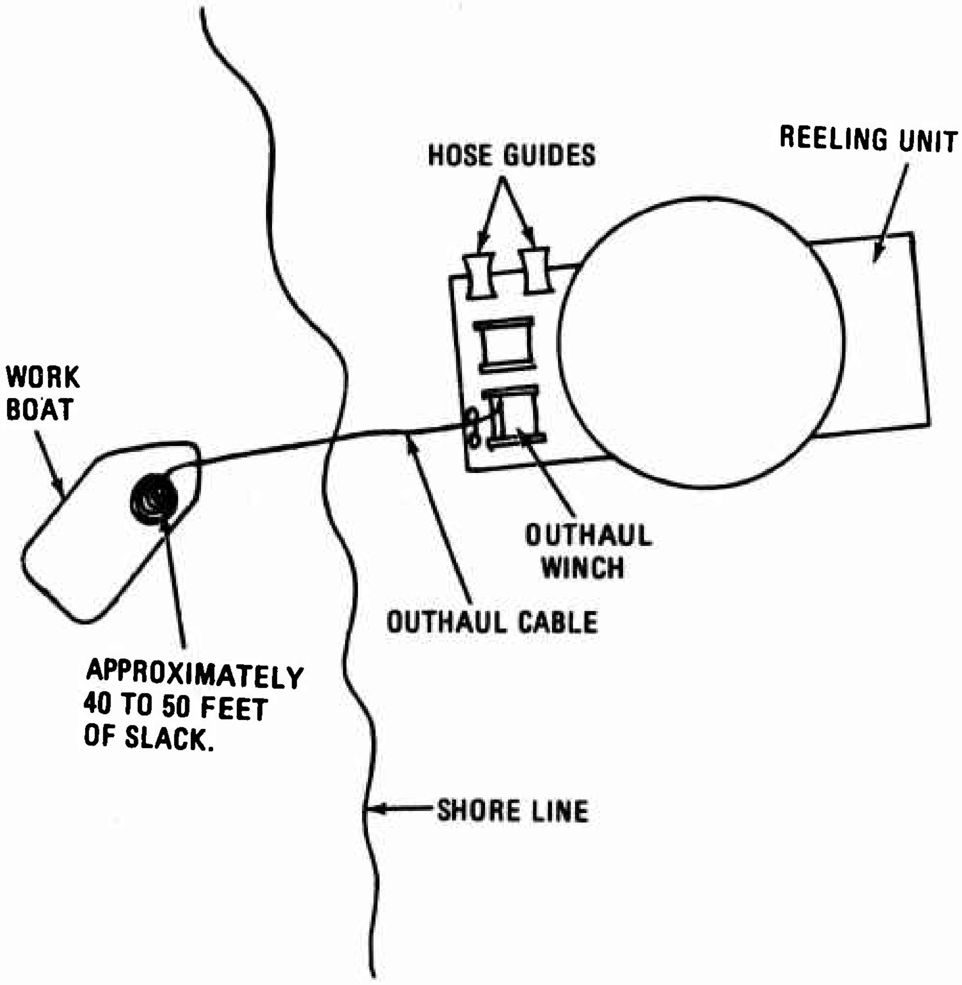

Fig. 14. Outhaul winch cable connection.

3. Unlock the shaft on the outhaul winch.

4. Proceed to the moored vessel with workboat operating at its best speed. Brake the outhaul winch just enough to prevent it from overrunning when the boat stops pulling.

5. Pass the two snatch blocks aboard the vessel. Secure the two blocks to the vessel. Pass the excess 1/2-inch cable through the snatch blocks and return the free end to the workboat, as shown in Fig. 15.

6. Return to shore with the free end of the 1/2-inch cable.

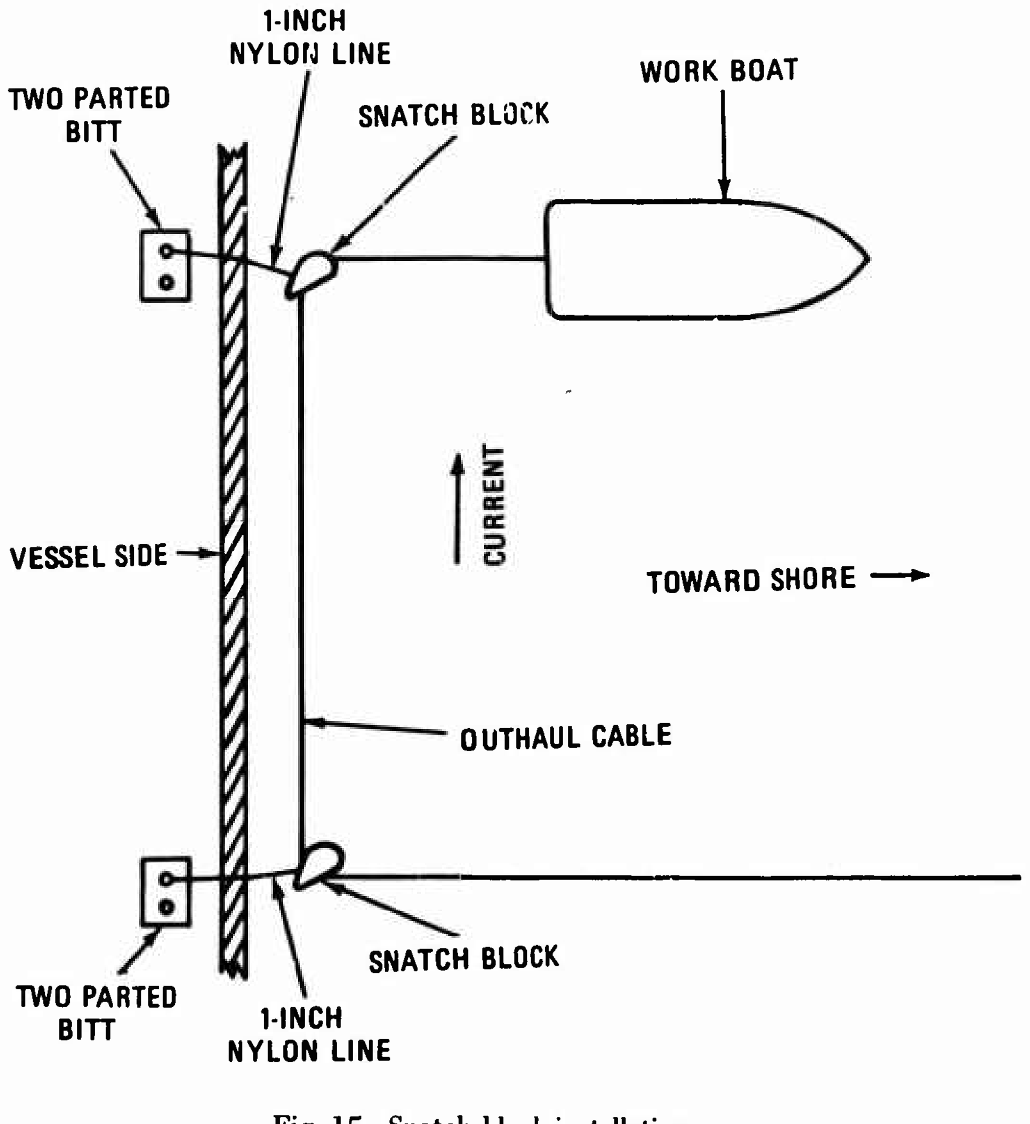

Fig. 15. Snatch block installation.

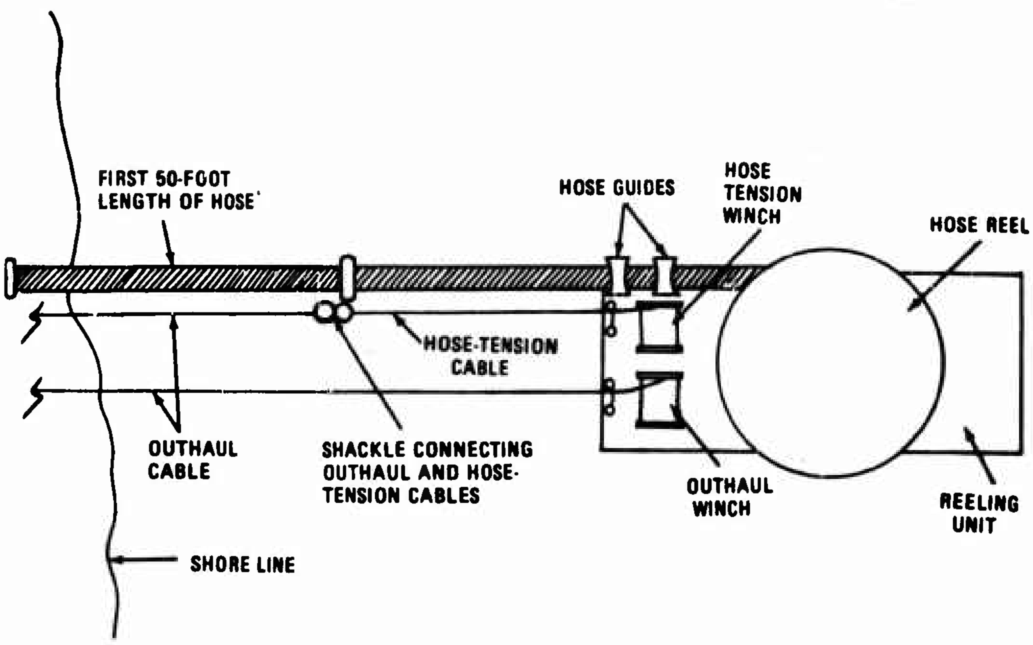

Fig. 16. Connecting outhaul cable to hose-tension cable.

7. Refer to Fig. 16 and connect 1/2-inch cable to the 5/8-inch hose-tension cable.

8. Unlock the shaft on the hose-tension winch.

9. Pull the hose-tension cable out by powering in on the outhaul winch. Use one operator to control the outhaul winch and fair-leader and the other to control the hose reel. The operator controlling the outhaul winch must apply enough braking force on the tension winch to keep it from overrunning.

10. Connect the first length of hose to the cables, as shown in Fig. 17.

11. Pull the hose-tension cable and hoseline out to the moored vessel, making the tension cable connections every 50 feet, as shown in Fig. 17. Also, connect a marker buoy to the tension cable 100 feet.

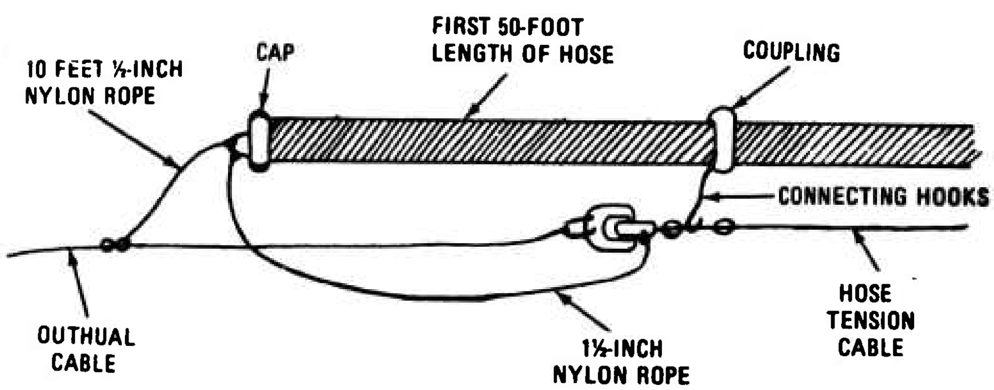

Fig. 17. Connecting outhaul cable to hoseline.

12. When the first length of hose reaches the side of the moored vessel, stop pulling while the first length is taken aboard and the 1/2-inch nylon rope is untied.

13. Continue pulling until the connection between the outhaul cable and tension cable reaches the snatch block.

14. Connect the tension cable to a bitt on the vessel with 1½-inch rope.

15. Connect the hoseline to the vessel's manifold. Lock the shaft and engage the pawl on the hose-tension winch. Put slack in the outhaul-winch cable.

16. After hoseline connections are complete, commence offloading.

(4) Purge the hoseline.

(a) Near the completion of the fuel-transfer operations, start the air compressor and see that the air pressure is 75 psig.

(b) At the completion of fuel transfer, signal the vessel crew to stop pumps and to open the pump bypass valves to the vessel fuel bunkers.

(c) Refer to Fig. 8. Attach the purging lateral pusher rod.

(d) Remove the pusher rod lockpin. Push the purging sphere into the sealed position.

(e) Close the fuel storage tank inlet valves.

(f) Connect the air-compressor hose to the purging lateral.

(g) Fuel purging now progresses with the fuel being expelled from the hose into the fuel vessel bunker(s). Observe the pressure gauge for any sudden drop in pressure to indicate that the purging sphere has arrived at the purging nipple on the vessel. A sudden escape of air through the purging nipple indicates that the purging sphere has arrived at the purging nipple.

(h) Signal completion of hoseline purging.

(5) Disconnect the hoseline.

(a) Disconnect hoseline from vessel manifold and replace blind flange on the hoseline end. Recover hoseline back on the reeling unit in the reverse manner of pulling it out (paragraph (b) above). Remove marker buoys and connecting links, and separate the hoseline every 250 feet.

(b) After hoseline and hose-tension cable are back on the unit, perform one of the two following steps, as desired:

1. Pass the snatch blocks to the workboat and tow the outhaul cable to one of the mooring buoys. Tie the assembly to the buoy (Fig. 18). Leave the assembly tied in this fashion until the next vessel is moored.

2. Remove snatch blocks and place outhaul cable overboard. Recover cable with the winch.

6. Development Chronology.

a. Flight Refueling, Inc., Design. Investigations of tactical equipment for offloading bulk POL from moored vessels to onshore storage facilities were conducted by USAMERDC in the early 1960's. Concepts using floating or submarine hoselines were considered. Extensive in-house testing was conducted on floating and submarine hose during this period. Work was also conducted on methods of emplacing the tactical hoselines, primarily on powered hose-reeling devices (see Fig. 19).

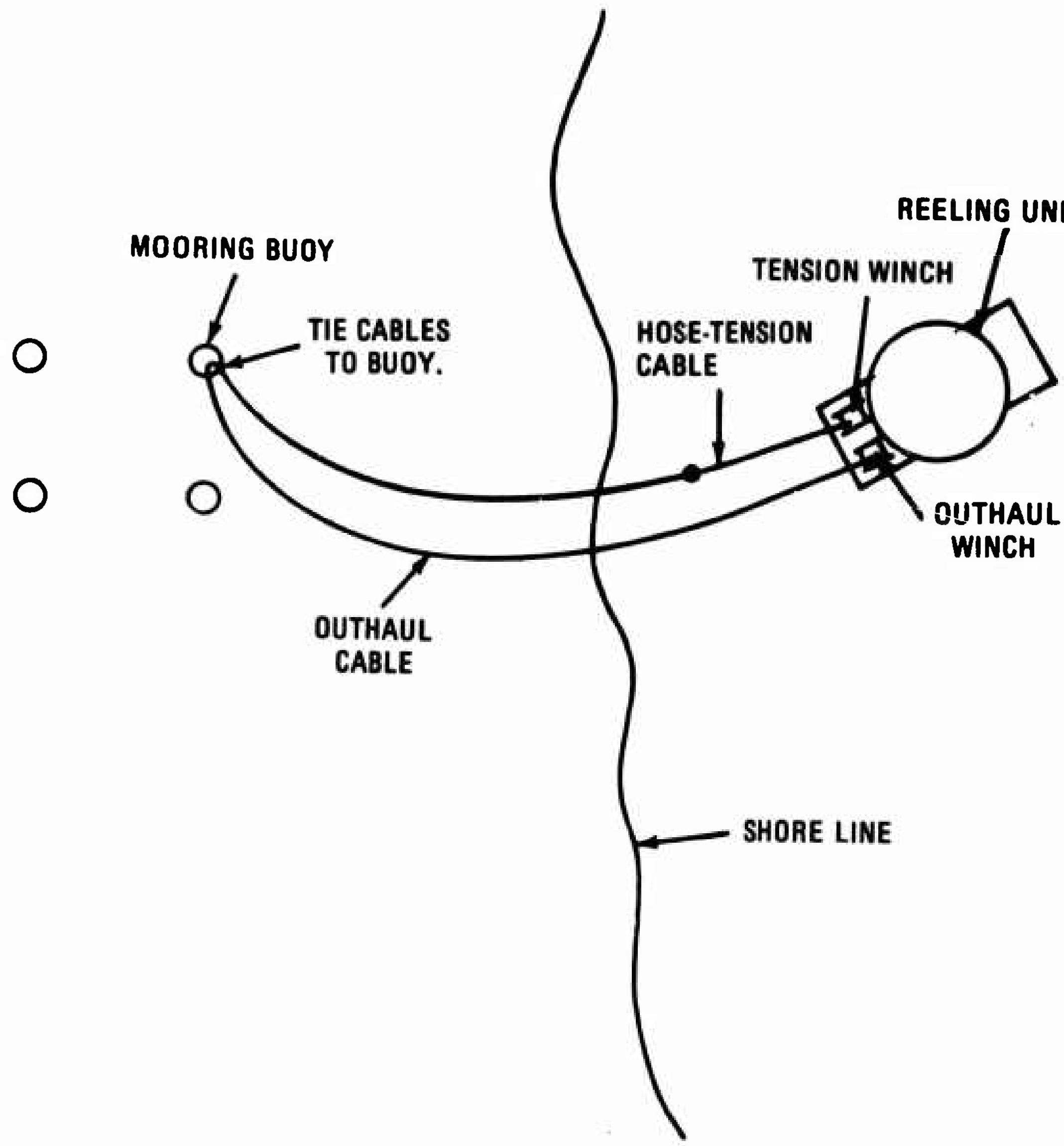

Fig. 18. Tying winch cables to mooring buoy.

Contract DA-44-009-AMC-92(T) for the design and fabrication of a floating-hoseline system was awarded to Flight Refueling, Inc. (FRI) of Baltimore, Maryland, on 23 January 1963. (The FRI name was changed to Aeronca Manufacturing Corp. in 1964, and then to Allied Research Associates, Inc., Baltimore Division, in 1966.) The USAMERDC purchase description for this system is included as Appendix C. The general operational purpose and concept of the system was basically the same as described in paragraph 1. Requirements were detailed for an 8-inch floating hose, a tension-relief cable, a reeling machine, anchors, and marker buoys. Particular detail was

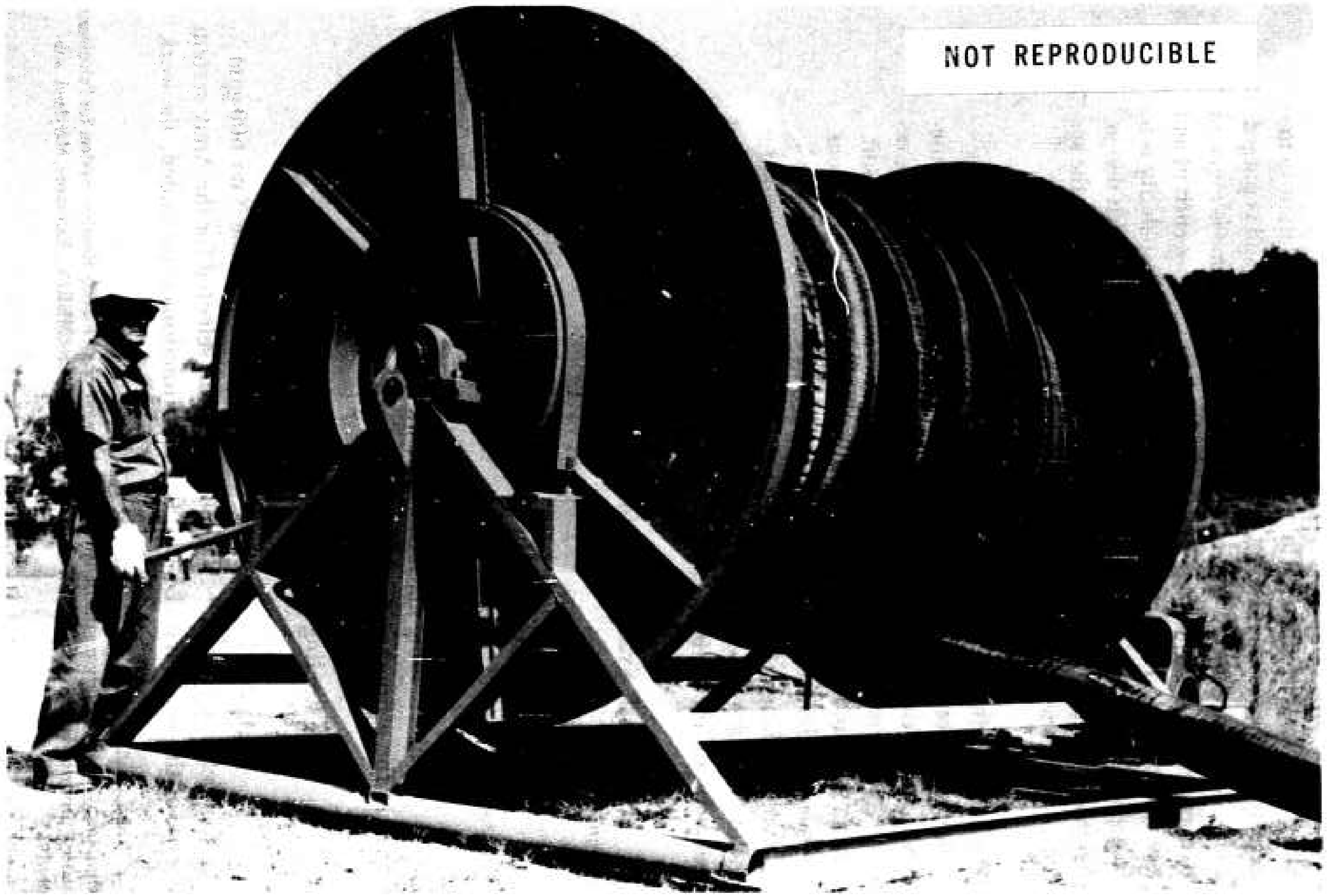

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Fig. 19. Early horizontal-axis reeling machine.

given in the requirements for the floating hose. The requirements for the system, as summarized by FRI,[3] were:

> The system is to be portable, and provide flexible installation to the extent that the line is installed only during offloading and is purged and stored at the end of fueling operations. The hoseline is required to operate in a salt water environment with 3-knot cross current and a surf condition with 2- and 4-foot breakers. System capability is to be normally of 500-foot length of 8-inch bore hoseline, with design for expansion to a 1000-foot length. Minimum shelf life for the system is 3 years with a minimum service life of 6 months.
>
> The hoseline System will consist of the 500-foot length of hose, composed of one 300-foot length and two 100-foot lengths, a hose-tension-relief cable attached to the hose at 50-foot intervals, the necessary reels for installation and retrieving the hose and cable, suitable anchors and floats to install the system, equipment provisions for securing the cable to the vessel and the shore, sea and shore markers for designating the offloading area, four-point mooring for the offloading vessel, and attendant tools and spare parts to support and maintain the system.

(1) **Overall System.** FRI investigated three operational concepts for the system:

(a) Reeling machine semipermanently installed on an LCM-8 landing craft.

(b) Reeling machine carried on the LCM-8 and temporarily transferred to the offloading vessel for fuel transfer operations.

(c) Reeling machine installed on the shore.

Method (a) is similar to the concept used for the Navy 600-gpm buoyant fuel delivery system.[4] Method (a) was not selected for the Army system because use of the workboat (LCM-8) for other functions is precluded; the work

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[3]Flight Refueling, Inc., "Phase I—Study on the Design and Development of a Floating Hoseline System for Petroleum Discharge Service," performed under contract DA-44-009-AMC-92(T) to USAMERDC, Baltimore, Maryland, submitted 24 July 1963.

[4]Traffalis, J. J., "600-GPM Ship-to-Shore Bulk Fuel Delivery Systems," U. S. Naval Civil Engineering Laboratory Report R 202, Port Hueneme, California, 29 June 1962.

area on the LCM-8 is too restricted for coupling and uncoupling the hose and fittings; since the workboat does not pass the end of the hose-tension cable to the offloading vessel, the workboat must be made fast to the vessel to accommodate the hoseline tensile loads; the workboat was considered overly susceptible to grounding. (The latter two disadvantages can be overcome easily, as has been done in the Navy system.)

Method (b) was immediately abandoned because of the safety and rigging problems inherent in the transfer of large equipment between vessels at sea.

Method (c) was adopted for the Army system, because unrestricted work area for preparation, operation, and maintenance of the equipment is provided; a stable platform for finite control and safety of operating personnel is provided; buoys can be attached to the hoseline on shore; problems with damage or grounding of a specific workboat are reduced; and versatility of the workboat is not compromised by requiring special equipment installation.

(2) **Reeling Machine.** Two basic concepts were considered for the reeling machine. The concepts are essentially the same, differing mainly in the orientation of the axis for the hose reel. One concept uses a vertical axis for the reel, and the second uses a horizontal axis. Both concepts utilize separate storage reels for the hoseline and the tension cable; both have the cable reel, the hose reel, the engine and transmission, and controls mounted on a single base structure; and both incorporate manual controls for simplicity, with independent clutching and braking provisions. The vertical-axis configuration for the hose reel was considered to offer the following advantages:

(a) Eliminates need for a transverse-guiding mechanism for the hoseline.

(b) Reduces crushing effect of layers of hoseline wrapped on one another.

(c) Provides a lower center of gravity for the reeling machine.

The FRI-designed reeling machine is shown in Figs. 20 and 21. The dimensions are: length, 218.5 inches; width, 125.5 inches; height, 82 inches; weight, 9000 pounds (with cable and 500 feet of hoseline).

Standard aluminum structural sections were used as much as possible in the fabrication. Power was supplied by a 24-bhp, gasoline, air-cooled engine. The power transmission comprised a triple-strand roller chain, a worm gear speed

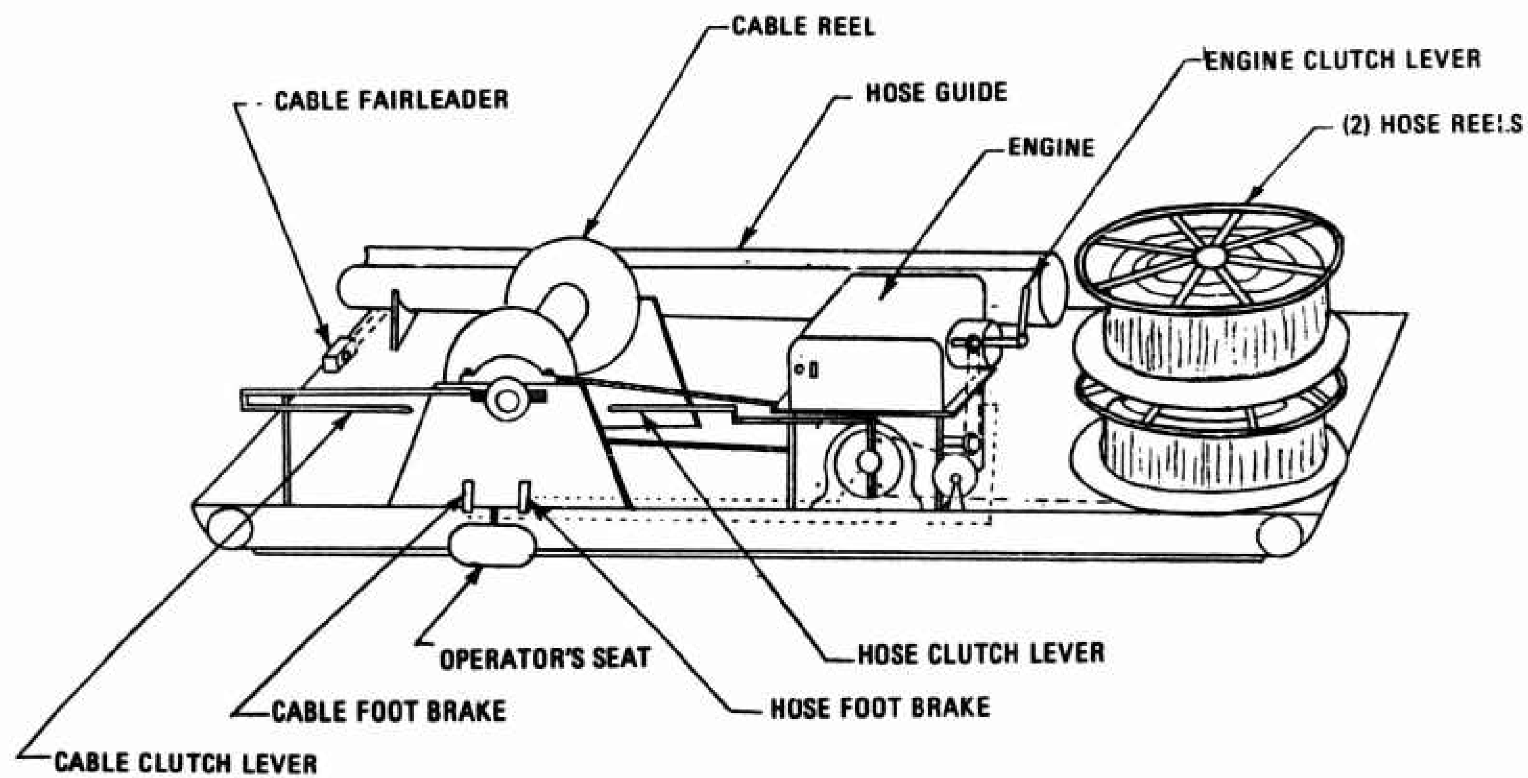

Fig. 20. Diagram of FRI reeling machine.

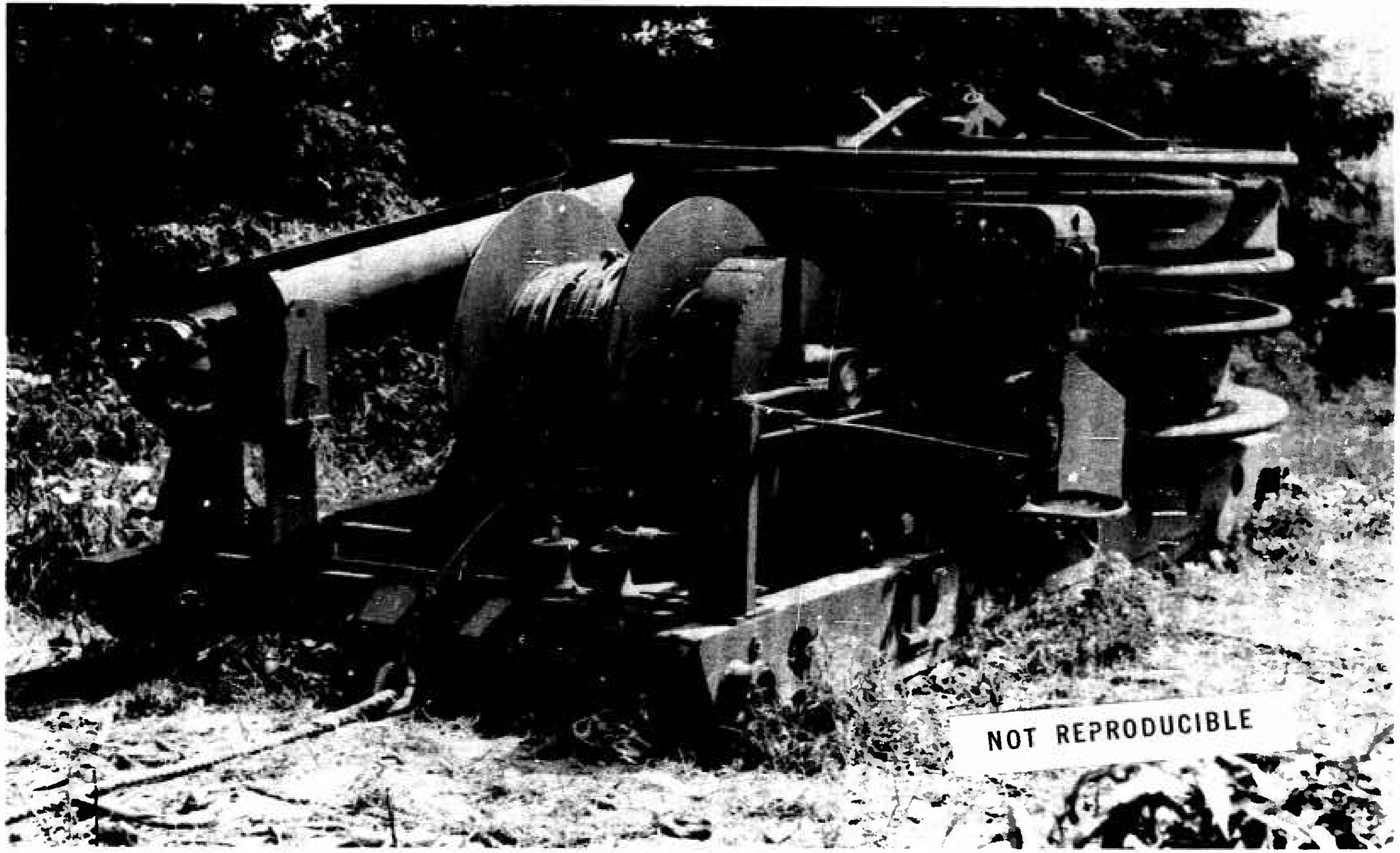

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Fig. 21. FRI reeling machine, 1965.

reducer, and manually operated jaw-type clutches (clutch teeth are meshed when the clutch is engaged) for both the hose reel and cable reel. The hose reel did not rotate on conventional bearings, but used multiple roller casters. The reel had sufficient capacity for 500 feet of hoseline. The hose reel was driven by a continuous length of 5/16-inch-diameter steel cable. The hose reel freewheeled during hoseline installing and was controlled by a drum brake. During recovery of the hoseline, the reel operated to limit the hoseline speed to a maximum of 78 feet per minute. The cable reel was designed for 1000 feet of 5/8-inch-diameter cable. A manually operated cable fairleader was mounted on the base structure in front of the cable reel. Controls comprised the following (Fig. 20): Cable reel clutch, hose reel clutch, cable reel brake, hose reel brake, fairleader crank, engine starting clutch, and engine controls.

(3) **Hose.** The 8-inch floating hose was developed by Raybestos-Manhattan, Inc., Passaic, N. J., under subcontract to FRI. The USAMERDC purchase description (Appendix C) was supplemented by addition of cold bend tests, purging tests, and end-fitting tests. A sketch of the hose design is shown in Fig. 22. Tests of initial 8-foot and 100-foot hose sections were conducted. Problems were encountered with the end fittings at 200 psi proof pressure, with air blisters on the outer wraps of the hose cover, and with failure at the splices in the 100-foot section. These problems were solved by using epoxy adhesive at the end fittings, by better quality control in manufacture, and by limiting the length of hose sections to 50 feet.

The Army specified (Appendix C) use of two 100-foot lengths of hose and one 300-foot-length of hose to make 500 feet of hoseline. The concept was abandoned in favor of 50-foot sections of hose, for the following reasons (in addition to that given above):

(a) To standardize on one length of hose.

(b) More unused hoseline can be left on the reel.

(c) Easier transportation.

(d) Quicker, easier, and cheaper repair.

(e) End fittings take up less space on the reel than splice fittings.

(f) More convenient and practical connection of hoseline to tension cable.

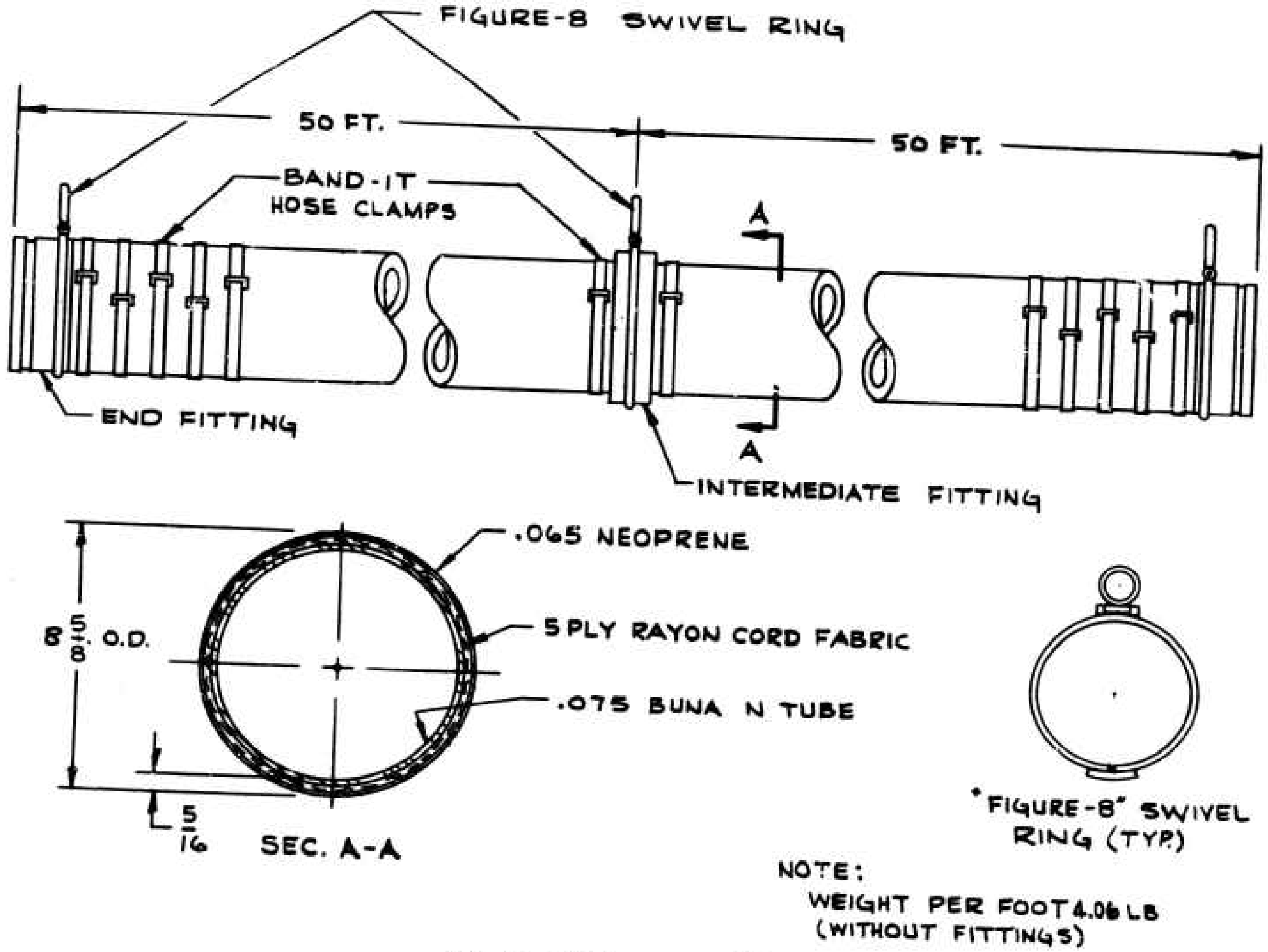

Fig. 22. FRI hose assembly.

Marker buoy assemblies (see paragraph 4) were attached to the hoseline every 50 feet. It was decided that installation of 50-pound Navy LWT anchors on the hoseline after the hoseline was installed in the water was impractical. Subsequent study by FRI indicated that these anchors were not needed for the lengths of hoseline used in the system.

The hoseline purging components were essentially the same as those described in paragraph 4.

(4) **Mooring.** The USAMERDC purchase description (Appendix C) specifies the use of 100-pound Navy LWT anchors in four mooring legs for securing the vessel while bulk fuel is offloaded. The FRI study indicated that the anchor size would have to be markedly increased to sufficiently constrain a vessel while offloading fuel through the floating hoseline. Use of explosive embedment anchors[5] or larger Navy anchors was recommended. The concept of a four-legged mooring was considered satisfactory. Eventually, the mooring system using the 2000-pound Navy LWT anchors described in paragraph 4 was adopted.

(5) **System Tests.** The FRI-designed and -fabricated floating-hoseline system was delivered to USAMERDC in June 1965. Initial testing of the system was conducted at USAMERDC during July and August 1965. Most of the system installing and operating procedures were tested (with the exceptions of mooring a vessel, connecting the hoseline to a moored vessel, pumping fuel through the hoseline, and purging the hoseline). The hoseline was installed as shown in Fig. 23 The mooring system was installed with an LCM-8 warping tug, as illustrated in Fig. 24. During these tests, the overall performance of the system was satisfactory. Some difficulty was encountered, however, with the cable reel clutch and with the brake assemblies.

Testing was continued during the period of 30 August to 3 September 1965 at Fort Story, Virginia. The reeling machine was transported to the testing area in an LCU landing craft and dragged onshore with an Army crawler tractor (Fig. 25). The LCM-8 warping tug was able to install the four mooring legs in approximately 2 hours. Tests with the hose-reeling machine demonstrated the feasibility and desirability of operating the machine on the beach, rather than on the workboat. Also, the desirability of using a powered tension-relief cable with the hoseline was demonstrated. Several functional and mechanical deficiencies were encountered, however, with the FRI reeling machine. These deficiencies prevented rapid, trouble-free deployment of the hoseline from the beach to the moored vessel.

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[5] Christians. John A. and Edward P. Meisburger, "Development of Multi-leg Mooring System, Phase A--Explosive Embedment Anchor," USAMERDC Report 1909-A, December 1967.

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Fig. 23. Installing hoseline with FRI reeling machine.

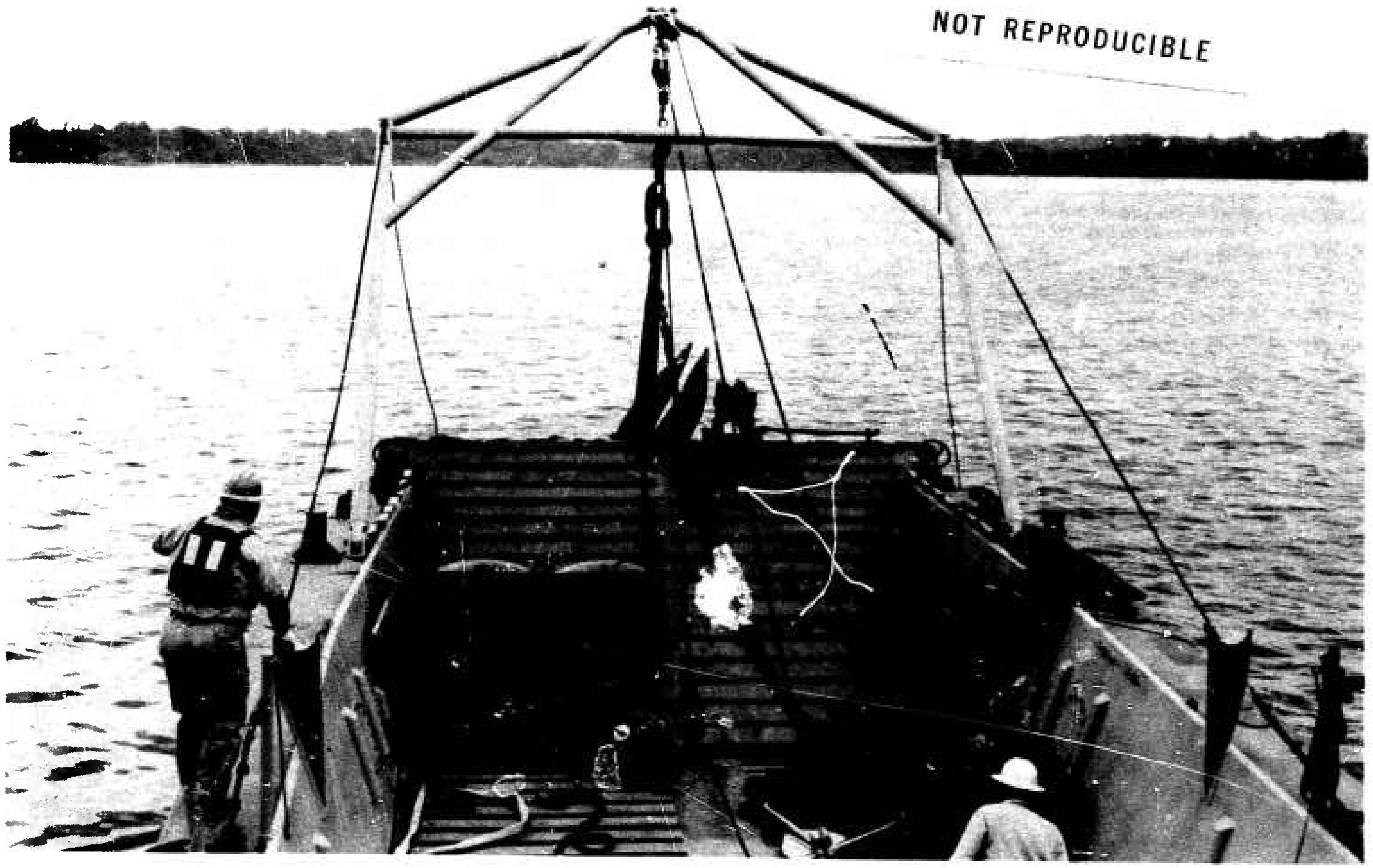

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Fig. 24. Installing mooring legs with LCM-8 tug.

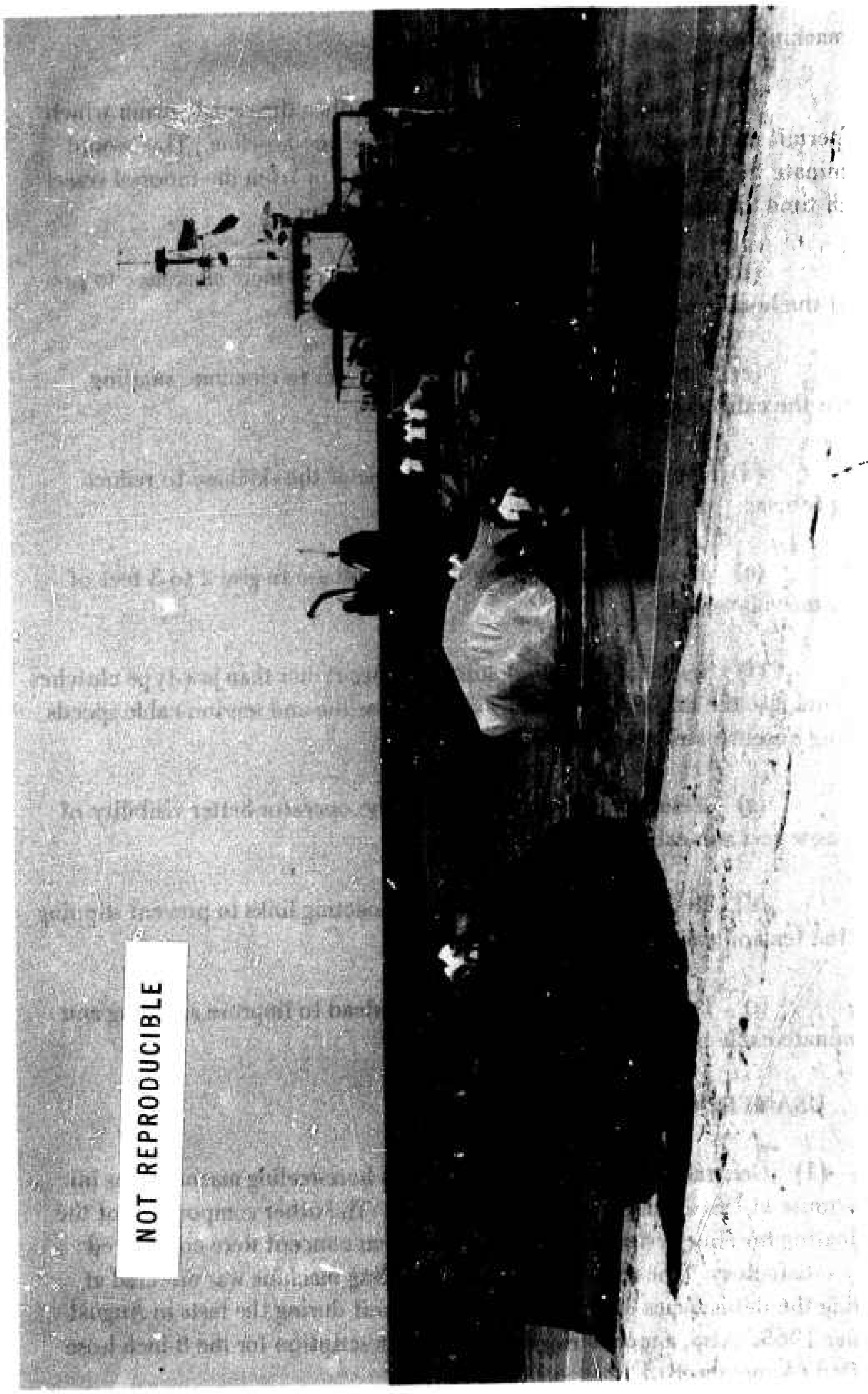

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Fig. 25. Delivering FRI reeling machine to beach.

The deficiencies in and proposed corrective actions for the FRI reeling machine were:

(a) Incorporate a two-drum winch rather than single-drum winch to permit more rapid installation and recovery of the hoseline. This would eliminate the necessity for boating the hoseline to or from the moored vessel each time the hoseline is deployed.

(b) Redesign the hoseline guide to provide more clearance to prevent the hose couplings from binding and snagging.

(c) Improve the brakes on the cable reel to eliminate snarling when the cable is slacked.

(d) Increase the ground-contact area of the skidbase to reduce drag forces.

(e) Elevate the machinery on the skidbase to give 2 to 3 feet of clearance above the ground.

(f) Use friction or hydraulic clutches rather than jaw-type clutches to eliminate the difficulty of synchronizing hoseline and tension-cable speeds during hoseline stringing operations.

(g) Relocate the controls to give the operator better visibility of the hose reel and cable reel.

(h) Redesign the hose-to-cable connecting links to prevent slipping on the tension cable.

(i) Provide power for the cable fairlead to improve spooling and eliminate cable pileup on the cable reel.

b. USAMERDC Design.

(1) **General.** The design of an improved hose-reeling machine was initiated in-house at USAMERDC in September 1965. The other components of the 8-inch floating-hoseline system and the overall system concept were considered generally satisfactory. The redesign of the hose-reeling machine was directed at eliminating the deficiencies discovered in the FRI unit during the tests in August-September 1965. Also, a more stringent purchase description for the 8-inch hose was drafted (Appendix B).

Formal development work on the 8-inch floating-hoseline system was terminated on 24 April 1967. The U. S. Army Combat Developments Command (USACDC) indicated that a proposed Qualitative Materiel Requirement (QMR) would not be processed to Department of Army Staff as a requirement. In effect, this USACDC action withdrew the Army requirement for the development of a floating-hoseline system. However, informal development was continued into 1970, as indicated below.

(2) **Reeling Unit.** Fabrication of the first USAMERDC-designed prototype was completed in October 1966. This reeling unit was essentially the same as described in paragraph 4 except for two features. The first prototype did not have brakes on either of the cable winches. Also, a screw-jack-type tension idler sheave without springs was used on the cable drive of the hose reel (see Fig. 26).

After the tests at Fort Belvoir and at Fort Story in 1966 and 1967 (see paragraph (4) below), disc brakes were added to both winches and a spring-type idler sheave was incorporated in the hose reel cable drive assembly. These modifications were completed on two units in March 1968. The resulting hose-reeling units are the same as those described in paragraph 4.

(3) **Hose.** Work on improved hose continued with the award of contract DA-44-009-AMC-1690 (T) to the United States Rubber Co., Passaic, New Jersey, on 24 May 1966 (name changed to Uniroyal, Inc., on 27 February 1967). The contract specified the design, fabrication, and testing of 50-foot lengths of 8-inch floating hose (see Appendix B). Preproduction lengths of hose were received in November 1966 and were considered generally satisfactory. USAMERDC tests indicated that the only serious shortcoming was in the adhesion of the hose tubing to the reinforcing fabric after fuel immersion (2.45 pounds/inch rather than 10 pounds/inch). Unfortunately, a strike at U. S. Rubber's plant prevented final delivery of all the required lengths of hose until January 1968. The final hose design (see paragraph 4) has a construction as follows:

(a) **Nipples.** Two-band anodized-type 6061-T6 aluminum nipples with Victaulic grooves and swivel ring attached.

(b) **Tube.** Paracril tube of 0.063-inch gauge, compounded to resist hydrocarbon fuels, as specified in Appendix B.

(c) **Center Plies Reinforcement.** Four plies of high-strength rayon cord impregnated with chloroprene rubber for maximum adhesion. Applied in alternate directions at the proper angle to minimize elongation.

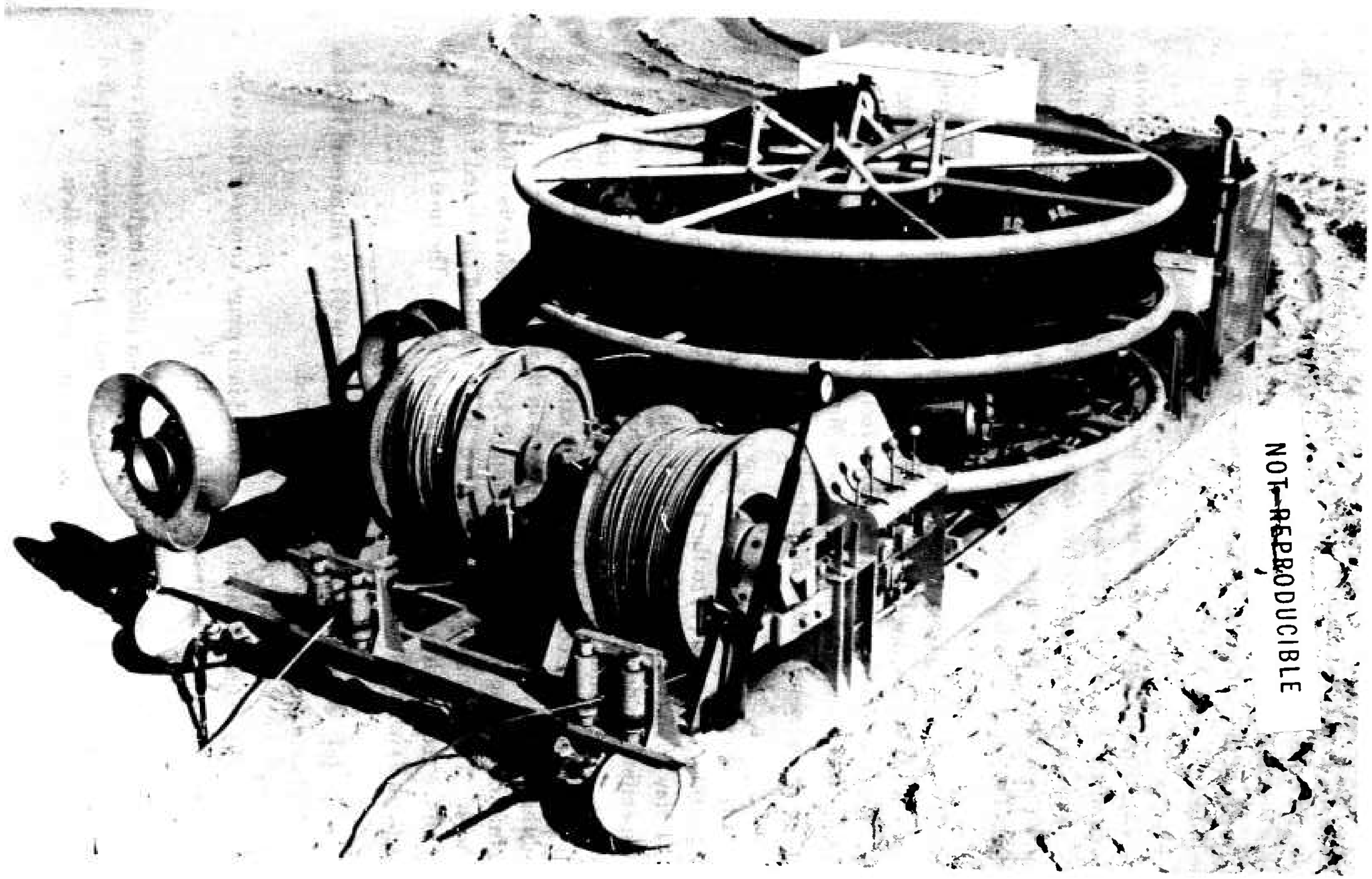

Fig. 26. Prototype reeling unit, 1967.

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(d) End Reinforcement. One ply, the same as the center plies (straight laid), to resist end thrust.

(e) Binding Wire. Number 7 copper-coated spring steel wire (0.177-inch-diameter) to tie in the carcass to the banded nipple.

(f) Cover. Chloroprene rubber, 0.063-inch gauge, compounded to resist fuels, water, weathering, abrasion, and fungus. Cover washed with ortho-phenyl-phenol to provide additional resistance to fungus growth.

(4) Testing.

(a) Reeling Unit. The prototype USAMERDC-designed reeling unit (paragraph (2) above) was subjected to preliminary tests at Fort Belvoir and, later, to an overall operational test at Fort Story, Virginia during the period of 6 to 16 February 1967 (see Fig. 26). The objectives of the test at Fort Story were to accomplish stringing and recovering a hoseline from the beach to a vessel anchored about 500 feet offshore and to establish the performance and adequacy of the prototype hose-reeling unit in a simulated operating situation. The test equipment included an LCM-8 landing craft, a 120-foot Army barge, a D-8 crawler tractor, and a LARC-5 amphibian.

The results of the test are:

1. The results of towing the hose-reeling unit (with hoseline on the reels) on dry beach sand indicate an average towing force of 9000 pounds. The penetration of the skids into the sand did not exceed 8 inches and did not cause contact of any of the machinery or cross framing supported by the skid.

2. Stringing of the outhaul cable using the LARC-5 indicated that powering the cable out with the hydraulic winches is too slow a process and causes maneuvering problems with the LARC-5. Freewheeling of the winches during hose stringing works well except for the lack of braking control on the winches.

3. Considerable problems were encountered with the screw-jack-type tension device on the hose-reel drive. At lower tension adjustments, it allowed the driving cable to slip because of small irregularities in the diameter of the cable groove mounted on the underside of the hose reel. At higher tension adjustments, the tension device failed structurally.

4. Synchronization of the cable and hose speeds was difficult with one reeling unit operator but satisfactory with two operators.

5. Installation and recovery of hoseline to the barge anchored offshore (using the LARC-5 as the workboat) was accomplished with general success (except as noted above) in about 1½ hours.

6. Forty-seven-foot spacing of the connector rings on the tension cable permits too much slack in the hoseline.

(b) Conclusions Derived from the Test.

1. The concept and design of the hose-reeling unit are satisfactory and commensurate with the mission requirements.

2. The hose-reeling unit can be towed on the beach with a D-6 or larger tractor or can tow itself by means of the hydraulic winches.

3. The unit can be operated by an onshore crew of as few as three men. A five-man crew is preferable, including two unit operators, two hoseline handlers, and one man in charge.

4. A LARC-5 amphibian or LCM-8 is satisfactory for service as the workboat during system operations.

5. The hoseline attachment points on the tension cable should be sized smaller to permit easy passage through the fairleader.

6. The hoseline fairleaders should be larger and should be fitted with lifting handles to facilitate positioning when hoseline from the upper reel is handled.

7. The cable fairleader should be strengthened.

8. Satisfactory friction brakes should be installed on both cable winches.

9. The screwjack-type tension sheave on the hose reel drive cable should be improved by incorporation of a spring-tension idler sheave and should be fitted with a means for quick adjustment of drive-cable tension.

10. The spacing of the connector rings on the tension cable should be 49 feet.

Two hose-reeling units were fabricated in-house at USAMERDC to rectify the shortcomings discovered in the tests at Fort Story. These units were completed in March 1968. Limited in-house testing verified that the units were satisfactory. These units represent the final design as described in paragraph 4.

(c) **Hose.** The late delivery of the redesigned (U. S. Rubber) hose prevented its testing during the system tests at Fort Story in February 1967. In-house testing indicated that the redesigned hose was an improvement over the Raybestos-Manhattan hose and that it was satisfactory for its intended usage. Results of a pressure-loss test are indicated in Table I.

Table I. Pressure-Loss Test Conducted on a 50-Foot Length of Floating Hose*

Flow Rate (gpm)	Hoseline Inlet Pressure (psi)	Pressure Loss (in. of water)	Fuel Temperature (^{o} F)	Ambient Temperature (^{o} F)
1000	100	21.2	54	42
800	100	13.6	54	42
600	100	8.4	54	42
400	100	3.7	55	42
200	100	0.3	55	42

*This test was conducted with the hose laid out straight and level and with a straight run of 8-inch pipe 40 feet in length installed at each end of the hose.

In July 1968, a request for 6- or 8-inch hose was received from the First Army Logistics Command in Long Binh, Vietnam. It was decided that fifty-nine 50-foot lengths of the USAMERDC 8-inch floating hose should be sent to Vietnam in response to this request. The hose was shipped in August 1968.

Information regarding the performance of the 8-inch hose in Vietnam was requested by letter in April 1970. The following information was received in May 1970:

1. **Service Life.** The hose has performed 5 months without problems. Longer time data are not available.

2. **Working Pressure.** Normally, 100 psi.

3. **Method of Use.** Floating hoseline of 1000-foot length and bottom-laid hoseline of 100-foot length.

4. **Number of Days Used Per Month.** Hose left in water continuously. Floating line left in water for 1 month and bottom-laid for 5 months.

5. **Type of Storage.** Crated, open storage, no visual effects.

6. **Environmental Conditions in which Hose is Used.** Hoseline used in a sheltered harbor, with relatively mild water and wind conditions.

7. **Failures Encountered.** Only failures were from exterior abrasions by ship's propellers and harbor debris.

8. **Recommendations.** Using units are very satisfied with the performance of the 8-inch floating hoseline.

III. DISCUSSION

7. **Discussion.** Analysis of the installing and operating techniques described herein indicate that the Army 8-inch floating-hoseline system is satisfactory for emplacing up to 1000 feet of 8-inch floating hoseline in sea conditions permitting tactical or amphibious-assault-type military operations. Although extensive testing of the final prototype was not accomplished, the experience gained over 8 years of development and the success of a similar Navy system reinforce this analysis.

The Navy 600-gpm buoyant fuel delivery system[6] is similar to the Army system in overall concept. The Navy system incorporates 6-inch hose and is capable of installing a 5000-foot hoseline. Unlike the Army system, however, the Navy system places the hose-reeling unit aboard the installing vessel and strings the hoseline as the vessel backs away from shore. The Navy system utilizes 100-pound anchors at 200-foot intervals to provide resistance to lateral currents and to hold the installed hoseline in the desired position.

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[6]Traffalis, *op. cit.*

Compared to the Navy system, the Army system requires less manpower and coordination during installation (hoseline anchors are not used). The 8-inch-diameter hose permits greater fuel throughput. The Army hose reeling unit is smaller and lighter. Examination of the dimensions and weight of the Army reeling unit indicate that use of a two-piece hose reel would permit air transport in a C-130 aircraft.

Comparison of the Army and Navy systems shows that, although similar, the two systems may be considered to fulfill complementary functions. The Navy system is more satisfactory for assault operations where greater distances offshore must be served and where air transportability is not essential. The Army system is more suited for tactical situations where air transportability is required.

Early efforts in processing Army requirement documents for a floating-hoseline system began in 1963 and did not consider air transportability. When formal development of the 8-inch floating-hoseline system was terminated in 1967, air transportability of Army equipment was not yet being emphasized. In August 1968, however, the Department of the Army approved a Qualitative Materiel Requirement (QMR) for a Multi-Leg Tanker Mooring System,[7] which authorized the development of a tactical mooring for T-2 tankers in which all components, including installing equipment, are air transportable in a C-130 aircraft. The 8-inch floating-hoseline system could be used in conjunction with this tactical mooring system.

IV. CONCLUSIONS

8. **Conclusions.** It is concluded that:

a. The system is satisfactory for installing, operating, and recovering up to 1000 feet of 8-inch-diameter floating hoseline under sea conditions permitting a tactical or amphibious assault operation.

b. The system should be satisfactory for military operations in which air transportability is required.

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[7]U. S. Army, "Development of the Army (DA) Approved Qualitative Materiel Requirement (QMR) for Multi-Leg Tanker Mooring System (Revised), 25 August 1968.

APPENDIX A

TABULATED DATA FOR 8-INCH FLOATING-HOSELINE SYSTEM

(1) **Reeling Unit.**

(a) **Engine**

20-hp gasoline, Military Standard	
Manufacturer	Continental Motors
Model	4A084-LL
Serial number	L003211
Cylinder/cycles	4/4
Cooling system	Air-cooled
Bore/stroke	3 x 3
Displacement	84 cubic inches
Crankcase capacity	4½ quarts

(b) **Winch hydraulic pump**

Manufacturer	Vickers
Type	In-line position
Model	PVB 45-FRSF-10D-10

(c) **Reel pump**

Manufacturer	Vickers
Type	Vane
Model	M214-9W-1A-12-S214

(d) **Return line filter**

Manufacturer	Vickers
Type	Low-pressure
Model	OFM-100

(e) **Check valves**

Manufacturer	Vickers
Type	Right-angle

Models	C2-825-520 and C2-820-520

(f) **Relief valve**

Manufacturer	Vickers
Type	Balanced piston
Model (winch circuit)	CT-10-F-10
Model (reel circuit)	CT-06-F-10

(g) **Reel motor**

Manufacturer	Vickers
Type	Fixed displacement, piston
Model	MF2003-23-12-20

(h) **Winch motors**

Manufacturer	Vickers
Type	Fixed displacement, piston
Model	MF2012-30-61-21

(i) **Pump inlet filter**

Manufacturer	Vickers
Type	Tell-tale (R)
Model	50-S-149-M-3-P3-44

(j) **Fairleader hydraulic cylinder**

Manufacturer	Vickers
Model	W31-FC-NC-SBV 2-1/2 x 24

(k) **Reel control valve**

Manufacturer	Vickers
Model	CM-11-N02-15DL

(l) **Winch control valves**

Manufacturer	Vickers
Model	CM2-N02-R22-DDL

(m) **Fairleader control valve**

Manufacturer	Vickers
Model	C-476-C

(n) **Reel drive speed reducer**

Manufacturer	United Shoe Machinery Corp.
Model	HDUC-65 type 0
Reduction ratio	104 : 1
Output torque	10,500 pounds at 500 rpm

(o) **Winch drive speed reducers**

Manufacturer	United Shoe Machinery Corp.
Model	HDUC-100 type I
Reduction ratio	182 : 1
Output torque	75,000 in. lbs at 1800 rpm

(p) **Cable (hose-tension winch)**

Federal specification	RR-W-410A, type I, class 2, 6 x 19, IPS, IWRC, galvanized
Length	1500 feet
Size	5/8-inch diameter

(q) **Cable (outhaul winch)**

Federal specification	RR-W-410A, type I, class 2, 6 x 19, IPS, IWRC, galvanized
Length	2500 feet
Size	1/2-inch diameter

(r) **Reel pump timing belt**

Manufacturer	U. S. Rubber Co.
Model	450 HO 75
Pitch	1/2 inch
Pitch length	45 inches
Teeth	90
Width	3/4 inch

(s) Winch pump timing belt

Manufacturer	U. S. Rubber Co.
Model	360 H 200
Pitch	1/2 inch
Pitch length	36 inches
Teeth	72
Width	2 inches

(t) Pulley (engine shaft)

Manufacturer	U. S. Rubber Co.
Model	TL 24H300 Type 2F
Pitch between flanges	3-5/16 inches
Pitch diameter	3.820 inches
Grooves	24

(u) Pulley (winch pump)

Manufacturer	U. S. Rubber Co.
Model	48820 Type 4F
Pitch between flanges	2-11/32 inches
Pitch diameter	7.639 inches
Grooves	48

(v) Pulley (reel pump)

Manufacturer	U. S. Rubber Co.
Model	72H-100 Type 9A
Pitch diameter	11.459 inches
Width	1-1/4 inches
Grooves	72

(w) Load rollers

Manufacturer	McMaster
Model	2436-1Y4

(x) Thrust rollers

Manufacturer	McMaster
Model	2436-1Y2

(y) **Reeling unit base**

MERDC Dwg No.	13211E6636

(z) **Winch pillow blocks**

Manufacturer	Browning Bloc
Model	PB 900
Bore size	4-15/16 inches

(aa) **Reel drive sheave**

MERDC Dwg No.	13211E6553

(bb) **Reel drive cable**

Manufacturer	Wirelon Conveyor Rope
Type	AF
Stock No.	78451
Size	5/16-inch diameter, 6 x 19 wire coated with nylon to 3/8-inch diameter, endless
	49 feet 7 inches ± 1 inch

(cc) **Hose reel**

MERDC Dwg No.	13211E6468
Material	Steel

(dd) **Storage box**

MERDC Dwg No.	13211E6673
Material	Steel

(ee) **Hydraulic tank**

MERDC Dwg. No.	13211E6620
Material	Steel
Capacity	65 gallons

(ff) Winches

MERDC Dwg. No.	132[illegible]E6460
Material	Steel

(gg) Caliper brakes

Manufacturer	Goodyear Industrial Brake Department
Model	PD-1428

(hh) Master brake cylinder

Manufacturer	Ford/Bendix
Part No.	B7QH-2140A

(ii) Brake reservoir

Manufacturer	Ford/Bendix
Part No.	B7T-2141-A

(2) Hose and hose fittings

(a) Hose

Manufacturer	U. S. Rubber Co. (Uniroyal) Passaic, N. J.
Diameter	8 inches
Length	50 feet

(b) Couplings w/gaskets

Manufacturer	Victaulic Corp.
Type	77
Size	8 inches

(c) Marker buoys

Manufacturer	Seaset
Model	D-4
Type	Inflatable, PVC, 20-inch diameter

(d) **Connecting hooks**

Manufacturer	Crosby Laughlin
Hood model No.	322C-3/4 ton
Hook type	Safety swivel
Link model No.	G-335-5/8 inch

(3) **Mooring system**

(a) **Anchor**

Size	2000-pound LWT
FSN	2040-377-8608

(b) **Anchor joining link**

Size	1 inch
FSN	4010-202-3546

(c) **Anchor chain**

Size	1 inch
Length	90 feet
FSN	4010-262-2586

(d) **Chain joining link**

Size	1 inch
FSN	4010-245-0466

(e) **Chain swivel**

Size	1 inch
FSN	4030-227-1461

(f) **Mooring buoy**

Yards and Docks Dwg No.	794-873
Height	6 feet
Diameter	6-3/8 inches
FSN	2050-223-3657

(g) **Anchor**

Size	100-pound LWT
FSN	2040-377-8600

(h) **Anchor joining link**

Size	3/4-inch
FSN	4010-202-3042

(i) **Anchor chain**

Size	3/4-inch
Length	90 feet
FSN	4010-262-2587

(j) **Chain swivel**

Size	3/4-inch
FSN	4030-227-1460

(k) **Anchor**

Size	750 pound LWT
FSN	2040-377-8605

(l) **Hawser**

Manufacturer	Samson Cordage
Material	Nylon
Size	4-inch circumference
Length	500 feet

(4) **Purging System**

(a) **Purging sphere**

Manufacturer	Maloney
Part No.	PS08
Nominal diameter	8 inches

(b) Purging fittings

Manufacturer	Aeronca Mfg. Corp.
Part Nos. Lateral	13211E6445
Nipple	13211E6451
Size	8-inch MIL-P-25995

(c) Air compressor

Type	Compressor, reciprocating, power-driven
Manufacturer	Worthington Corp.
Rating	55 DFM, 80 psi
Specification	MIL-C-10161
Technical manual	TM 5-4310-208-15

APPENDIX B

PURCHASE DESCRIPTION FOR FLOATING-HOSE ASSEMBLIES, 8-INCH, RUBBER; PETROLEUM DISCHARGE SERVICE ONLY

1 December 1965

1. SCOPE

1.1 This purchase description covers rubber hose assemblies for petroleum discharge, used as a component of a floating hose-line tanker unloading system.

2. APPLICABLE DOCUMENTS

2.1 The following documents form a part of this purchase description to the extent specified herein.

SPECIFICATIONS

Federal

QQ-P-416 – Plating Cadmium (Electrodeposited)

VV-F-800 – Fuel Oil, Diesel

Military

MIL-G-3056 – Gasoline, Automotive, Combat

MIL-P-3136 – Standard Test Fluids, Hydrocarbon

MIL-G-5572 – Gasoline, Aviation: Grades 80/87, 91/96, 100/130, 115/145

MIL-J-5624 – Jet Fuel, Grades JP-3, JP-4, and JP-5

MIL-F-16884 – Fuel Oil, Diesel

MIL-C-10387 – Coupling; With Bolts and Synthetic Rubber Gasket, for Grooved End Pipe and Tube

MIL-P-10388 – Pipe Fittings: One or More Ends Grooved

MIL-F-46005 – Cite Fuel, type 1

STANDARDS

Federal

Federal Test Method
STD. No. 601-Rubber: Sampling and Testing

Military

MIL-STD-129 – Marking for Shipment and Storage

MIL-STD-130 – Identification Marking of U. S. Military Property

(Copies of specifications, and standards required by contractors in connection with specific procurement function should be obtained from the procuring activity or as directed by the Contracting Officer.)

DRAWINGS

U. S. Army Mobility Command

D13211E6479A

D13211E6481

3. REQUIREMENTS

3.1 Description. Each hose assembly shall consist of a reinforced synthetic rubber hose, furnished with grooved-type end nipples, grooved-type couplings, grooved-type caps, and Cadmium-plated swivel rings, as shown in Drawing D13211E6481. The hose assemblies will be used as components of a floating hoseline system for the offshore transfer of petroleum products as specified herein. The hose shall be designed for the environmental conditions and physical properties specified herein.

3.1.2 Environmental and operational requirements. The hose assembly shall be suitable for use under the following environmental and operating conditions.

a. The hose assembly shall be capable of withstanding installation and operation under sea and beach conditions. In general, these conditions would be 2- to 4-foot waves (Sea State 3), a 20-knot wind (Beaufort Scale 4), and a cross current of 3 knots.

b. The hose assembly shall be designed to resist effects of fresh and salt water when it is exposed to it while empty or filled with the petroleum products specified therein.

c. While subjected to the conditions described under paragraphs (a) and (b) above, the hose assembly shall allow a rate of flow of 1500 bbl/hr at 100 psi pressure.

d. The hose assembly shall have a bending diameter of no less than 36 inches.

3.2 Hose samples. Three sample lengths shall be provided which are identical in construction to the hose assemblies which the manufacturer will subsequently produce in fulfillment of the contract. The sample lengths for demonstration of compliance with the requirements of this purchase description shall be as follows:

a. An 8-foot length with vulcanized built-in end fittings.

b. Two 50-foot lengths with vulcanized built-in end fittings. The contractor's examinations and tests shall be those specified herein. Any changes or deviations in the design and development of the sample evaluation units shall be subject to the approval of the Contracting Officer.

3.3 Material. Material shall be as specified herein. Materials not specified shall be selected by the contractor and shall conform to all the provisions of this purchase description.

3.4 Hose. The hose shall be a semi-collapsible type and consist of an inner tube, two or more plies of reinforcement material, and a protective cover. All layers shall be bonded to each other and vulcanized to produce a unified hose wall. The hose assemblies shall have an 8-inch nominal inside diameter and shall weigh not more than 5 pounds per foot. The length of the hose assemblies shall be as specified in the contract and shall be measured from the extreme ends of the hose nipples.

3.4.1 Inner tube. The rubber inner tube shall be of homogeneous composition, free from extraneous inclusions, and uniform in thickness. The interior surface shall be smooth and free from pitting, and shall be clean of all foreign materials and mandrel lubricants. The tube shall not be affected by prolonged exposure to aromatic hydrocarbon fuels and shall not affect the quality of these fuels. The fuels shall be those as specified herein.

3.4.2 Reinforcement material. The reinforcement material shall be evenly and firmly fabricated and shall be free from dirt, knots, lumps, irregularities of twist, or other defects which may impair the serviceability of the hose. The reinforcement material shall be uniformly distributed throughout the full length of the hose and shall not be exposed at any place on the hose.

3.4.3 Cover. The protective cover shall be fully resistant to hydrocarbon fuels, fresh and sea water, ozone weathering, abrasion and marine growths. The cover shall be uniform in thickness, smooth, and free from slits, cracks, or holes. Vulcanization shall not be permitted when repairing. The ends of the cover shall extend over and be vulcanized to the ends of the inner tube and the reinforcement material.

3.5 End nipples. End nipples shall be fabricated from an aluminum alloy resistant to the corrosive effects of immersion in fresh and sea water. The end nipples shall be as shown in Drawing D13211E6479A. The nipples shall be vulcanized to the hose in a "built-in," inseparable configuration. Each nipple shall be equipped with Figure-8 swivel ring for attaching the tension relief cable, as shown in Drawing D13211E6479A. The steel, cadmium-plated swivel rings shall be free to rotate around the nipple. The nipples shall withstand the forces and environments arising from exposure to operational conditions throughout the service life specified in this purchase description.

3.6 Coupling. Two 8-inch aluminum couplings conforming to Military Specification MIL-G-10387 shall be furnished per section of hose. Couplings shall be furnished with cadmium-plated steel bolts and gaskets.

3.7 Protective Caps. Two protective caps conforming to Military Specification MIL-P-10388 shall be furnished per section of hose. Each cap shall be provided with a ring for towing the hose. Caps shall be fabricated from an aluminum alloy.

3.8 Dimensional changes and tolerances.

3.8.1 Diameter. The outside diameter tolerance over the length of the hose assembly shall be ± 1/8 inch at zero pressure. When the hose assembly is subjected to an internal pressure of 100 psi, the change in the outside diameter shall be not more than ± 5 percent of its original value.

3.8.2 Length. The hose assembly length tolerance shall be ± 2 percent. When the assembly is subjected to an internal pressure of 100 psi, the change in length of the assembly shall be not more than ± 5 percent of the original measured length.

3.8.3 Twist. The hose assembly shall not develop a twist exceeding 30° per 100-foot length when subjected to the design operating pressure of 200 psi.

3.9 Performance.

3.9.1 Operating Temperature Requirements. The hose assemblies shall perform as specified herein at any ambient temperature from 0^{o} F to $+125^{o}$ F.

3.9.2 Flotation. The hose assembly shall float in water with a density of 62.4 pounds per cubic foot at a temperature of 35^{o} to 40^{o} F when filled with 0.85 specific gravity fuel.

3.10 Physical properties.

3.10.1 Friction. The friction between component parts of the hose shall not be less than 20 psi prior to exposure to fuel, and not less than 10 psi after exposure to fuel. Friction is the term used to denote the adhesion between component parts.

3.10.2 Tensile strength. The tensile strength of the inner tube and cover before exposure to fuel shall be not less than 1800 and 1600 psi, respectively. After exposure to fuel, the tensile strength shall be not less than 1200 and 1000 psi, respectively.

3.10.3 Ultimate elongation. The ultimate elongation of the tube cover before exposure to fuel shall be not less than 250 percent. After exposure to fuel, the ultimate elongation shall be not less than 150 percent.

3.10.4 Volume increase. The volume increase of the tube and cover, after exposure to fuel, shall be not more than 40 and 100 percent, respectively.

3.11 Proof pressure resistance. The hose assembly shall not seep, spray, split, or show any evidence of failure when subjected to a hydrostatic pressure of 200 psi.

3.12 Burst pressure resistance. The hose assembly shall not seep, spray, split, or show any evidence of failure when subjected to a hydrostatic pressure of 350 psi.

3.13 Accelerated aging. After subjection of the hose specimen to the aging test defined in paragraph 4.6.2.13, the tensile strength and elongation of the tube and cover shall not vary more than 25 percent from the tensile strength and elongation exhibited before aging.

3.14 Resistance to light. The tensile strength of the hose cover specimen after exposure to light tests for 100 hours as described in paragraph 4.6.2.14 shall not be less than 75 percent of the tensile strength exhibited before the light exposure.

3.15 Fungus resistance. The exterior (cover) and interior (tube) surfaces of the hose shall not show evidence of fungus growth when tested as specified in paragraph 4.6.2.15.

3.16 Resistance to extraction. Not more than 6 percent by weight of nonvolatile matter shall be extracted from the tube compound when subjected to the extraction test defined in paragraph 4.6.2.16.

3.17 Identification marking. Each hose assembly shall be identified in accordance with standard MIL-STD-130. Identification shall be affixed approximately 3 feet from each end of the hose assembly.

3.17.1 Additional marking. Each hose assembly shall have a 2-inch wide yellow stripe, on the outside, parallel to the bore to indicate the natural lay of the hose.

4. QUALITY ASSURANCE PROVISIONS

4.1 The supplier shall perform all inspections and test requirements as specified herein unless otherwise indicated. The supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government. The Government reserves the right to perform any of the inspections or tests set forth in the purchase description when they are deemed necessary to confirm that the end product complies to the prescribed requirements.

4.2 Classification of inspection. Inspection shall be classified as:

a. Preproduction inspection of the hose samples.

b. Production inspection of the hose assembly.

4.3 Evaluation inspection and tests. In addition to the inspection and tests conducted by the contractor, the Government will conduct all evaluation inspections and tests at the USAERDL, Ft. Belvoir, Va. on the hose samples specified in Paragraph 3.2. The contractor or his representatives may observe any inspection or test conducted by the Government.

4.3.1 Examination and tests. The hose samples shall be subjected to the examination and tests specified in Table II. Presence of one or more defects shall be cause for rejection.

4.4 Production inspection. Each production hose assembly shall be subjected to the inspections and tests specified in Table II.

Table II. Inspection Schedule

Inspection Sequence	Type of Inspection: Preprod. Length	Type of Inspection: Production Length	Examination or Test	Inspect. Para(s) of Spec.	Std. Test Para(s)	Requirement Paragraphs
1	X	X	Examination	4.6.1		
2	X		Operating Temperature	4.6.2.1		3.9.1
3	X	X	Diameter Expansion	4.6.2.2	2231 or 2351	3.8.1
4	X	X	Elongation of Length	4.6.2.3	2411	3.8.2
5	X		Negative Buoyancy	4.6.2.4		3.9.2
6	X	X	Proof Pressure Resistance	4.6.2.9	10211	3.11
7	X	X	Twist	4.6.2.12		3.8.3
8	X		Ultimate Tensile Strength	4.6.2.11		
9	X		Burst Pressure Resistance	4.6.2.10	10011	3.12
10	X		Adhesion	4.6.2.5	8011	3.10.1
11	X		Tensile Strength	4.6.2.6	4111	3.10.2
12	X		Ultimate Elongation	4.6.2.7	4121	3.10.3
13	X		Volume Increase	4.6.2.8	6211	3.10.4
14	X		Accelerated Aging	4.6.2.13	7111	3.13
15	X		Resistance to Light	4.6.2.14	7311	3.14
16	X		Resistance to Fungus	4.6.2.15		3.15
17	X		Resistance to Extraction	4.6.2.16	6511	3.16

4.5 Inspection schedule. Inspection schedule shall be as shown in Table II. All test methods shall be in accordance with Standard Federal Test Method STD. No. 601.

4.6 Inspection procedure.

4.6.1 Examination. The hose assembly shall be visually examined for overall conformance with the requirements of this purchase description.

4.6.2 Tests.

4.6.2.1 Operating temperature. Wind hose on a drum having a diameter of 36 inches. Condition the hose in temperature of 0^{o} F ± 2^{o} for a period of 24 hours. At end of conditioning period straighten the hose manually while maintaining the specified temperature. Cracking, splitting, or any evidence of failure in the hose shall constitute failure of this test.

4.6.2.2 Diameter expansion. The basic diameter of the hose shall be established with the hose under an internal pressure of not more than 10 psi. With the hose subjected to an internal pressure of 100 psi, measure the expansion in the diameter in accordance with Method 2231 and 2351. Contraction or expansion of more than 5 percent of the basic outside diameter shall constitute failure of this test.

4.6.2.3 Elongation of length. The basic length of the hose shall be established in accordance with Method 2411. Subject the hose assembly to an internal pressure of 100 psi and remeasure the overall length of the hose. Elongation of the hose length more than ± 5 percent of the basic hose length shall constitute failure of this test.

4.6.2.4 Flotation. Fill the hose assembly with an 0.85 specific gravity fluid under a pressure of 10 psi with both ends capped. Place the hose assembly in a body of water having a density of 62.4 pounds per cubic foot with sufficient depth to completely float the hose. Failure of the hose length to remain visible on the surface (approximately 25 percent diameterwise) shall constitute failure of this test.

4.6.2.5 Friction. Friction between component parts (layers) of the hose shall be tested in accordance with Method 8011. This test shall be conducted to samples both before and after exposure to fuel. Friction in the sample prior to exposure of less than 20 psi and after exposure of less than 10 psi shall constitute failure of these tests.

4.6.2.6 Tensile strength. The tensile strength of the inner tube and the cover shall be tested in accordance with Method 4111. Tests shall be conducted to samples both before and after exposure to fuel. Tensile strength of the inner tube and cover, prior to exposure to fuel, of less than 1800 and 1600 psi, respectively, and tensile strength of the inner tube and cover after exposure to fuel, of less than 1200 and 1000 psi, respectively, shall constitute failure of these tests.

4.6.2.7 Ultimate elongation. The ultimate elongation of the inner tube and cover shall be tested in accordance with Method 4121. The tests shall be conducted to samples both before and after exposure to fuel. An ultimate elongation of the inner tube and cover prior to exposure to fuel, of less than 250 percent, and an elongation of the inner tube and cover, after exposure to fuel, of less than 150 percent shall constitute failure of these tests.

4.6.2.8 Volume increase. The volume increase in the tube and cover after exposure to fuel shall be tested in accordance with Method 6211. A volume increase in the tube and cover of more than 40 percent and 100 percent, respectively, shall constitute failure of these tests.

4.6.2.9 Proof pressure resistance. Each hose assembly shall be tested for proof pressure resistance in accordance with Method 10211 and as follows:

The hydrostatic pressure shall be raised slowly to 200 psi and held for a period of 30 minutes. The pressure shall then be reduced to 0-5 psi and held for a period of 1 minute. This cycle shall be repeated 25 times. Seepage, evidenced by surface wetting, spraying, splitting, or any evidence of failure in the hose assembly shall constitute failure of this test.

4.6.2.10 Burst pressure resistance. The 8-foot hose assembly shall be tested for burst pressure resistance in accordance with Method 10011. Test pressure shall be applied for 5 minutes. Any evidence of failure, seeping, spraying, or splitting shall constitute failure of this test.

4.6.2.11 Ultimate tensile strength. An 8-foot hose sample assembly shall be tested to determine the longitudinal tensile strength of the hose and fitting. The test apparatus shall be as described in Method 4111. During the test, the hose assembly is to be pressurized with a fluid to 100 psig. Simultaneously apply an external tensile load of 3000 pounds to the hose fitting. Slippage or parting of the hose at the vulcanized end fitting shall constitute failure of the test.

4.6.2.12 Twist. A collar shall be installed on a free end of the sample hose during the proof pressure test. The hose free end shall rotate freely within the collar, which shall be stationary with respect to the hose. A line will be marked with a crayon or soft pencil on the top surface of the collar aligned with the center of the hose yellow line. The displacement between these lines at 200 psi pressure will be used for calculation of the amount of twist. The twist exceeding 30° per 100 feet of length shall constitute failure of these tests.

4.6.2.13 Accelerated aging shall be determined as described in Method 2111 of Standard, FED-STD-601. Tensile strength and elongation shall be used to determine the amount of property deterioration.

4.6.2.14 Light test. This test shall be conducted in accordance with specified method of Method 7311, of FED-STD-601.

4.6.2.15 Fungus Resistance Test.

4.6.2.15.1 Chaetomium Globosum Test, Culture medium. The culture medium shall have the following composition:

$NaNO_3$-------	3.0 gm
K_2HPO_4-------	1.0 gm
$MgSO_4 7H_2O$---	0.5 gm
KCl---------	0.25 gm
Agar---------	15.0 gm

Distilled water to make 1000 ml.

The pH shall be 5.5 to 5.6; if otherwise, adjust to that range with HCl or NaOH. After mixing, the above ingredients shall be sterilized by autoclaving for 15 minutes at 15 psi (121°). Under sterile conditions, the medium shall be poured into Petri dishes or other suitable containers for culturing, and allowed to solidify.

4.6.2.15.2 Test Organism. The organism used in this test shall be *Chaetomium globosum* A.T.C. 6205. Stock cultures of this organism shall be carefully maintained on strips or squares of sterile porous filter paper or blotter paper on the test agar medium specified in 4.6.2.15.1, and promptly renewed if there is evidence of contamination. The culture may be kept for not more than 4 months in a refrigerator approximately 3° C to 10° C. Subcultures incubated at 28° C to 30° C for 7 to 21 days shall be used in preparing the inoculum.

4.6.2.15.3 Inoculum. To a culture of the test organism in a ripe-fruiting condition add about 10 ml of sterile, distilled water containing about 0.005 percent of non-toxic wetting agent. Force the spores into suspension by brushing with a sterile camel's hair brush (or other suitable means) and dilute to 10 ml with sterile water.

4.6.2.15.4 Preparation of Test Specimens.

a. As-received Specimens. Six specimens, each 1½ inches square, selected at random shall be cut from the hose as received. Each specimen square shall then be split in two by cutting mid-point through its thickness to produce two separate thinner 1½-inch-square specimens of nearly equal thickness.

b. Fuel-immersed Specimens. Six specimens, each 1½ inches square, of the hose shall be immersed in 250 ml of test medium No. 6 conforming to Standard FED-STD-601, Method 6001, for 24 hours at 73.5° F ± 2° F. During the immersion period, specimens shall be separated from each other and shall not contact the inside surfaces of the container. At the end of the initial 24-hour immersion period, the test liquid shall be discarded and replaced with 250 ml of fresh medium No. 6. The immersion shall be continued for an additional 24 hours at 73.5° F ± 2° F. At the end of the second immersion period, the specimens shall be subjected to a third immersion in 250 ml of fresh medium No. 6. At the end of the third 24-hour fuel immersion period, the samples shall be removed from the test liquid and blotted. After drying for 1 hour at 73.5° F ± 2° F, the specimens shall be placed in an air-circulating oven at 135° F ± 2° F for 22 hours. After oven drying, the samples shall be removed and allowed to cool for 1 hour at 73.5° F ± 2° F. After cooling, each specimen square shall be split in two by cutting mid-point through its thickness to produce two separate thinner 1½-inch square specimens of nearly equal thickness.

4.6.2.15.5 Inoculation. Under aseptic conditions, dip each specimen in 70 percent ethanol for a few seconds, rinse thoroughly in distilled water, and place firmly on the center of the solidified agar medium contained in the 10-cm Petri dish. Place three specimens with the cover (exterior of hose) surface facing up in the dish, one specimen to each dish. Place remaining three specimens, one in each dish with the inner tube (interior of hose) surface facing up. With a sterile pipette or other suitable means, distribute approximately 1.5 ml of inoculum over the surface of the specimen and surrounding medium.

4.6.2.15.6 Controls. Five untreated specimens of blotting paper shall be tested along with the test specimens to check the visibility of the inoculum. At the end of the incubation period, the controls shall be covered with the fungus growth.

4.6.2.15.7 Incubation. The period of incubation shall be 14 days at a temperature of 28° to 30° C and a relative humidity of not less than 90 percent.

4.6.2.15.8 Results. Upon completion of the incubation period, the test specimens shall be examined microscopically (approximately 18X magnification). The hose shall be considered to have failed to meet the requirements of this purchase description when any of the test specimens show evidence of growth of the test organism.

4.6.2.15.9 Aspergillus Niger, Non-Nutrient Culture Medium, Test. This test shall be performed in accordance with the procedure specified in 4.6.2.15.1, except for the test organism.

4.6.2.15.10 Test Organism. The organism used in this test shall be Aspergillus Niger, A.T.C.C. 10535. Stock cultures of this organism shall be carefully maintained on a potato-dextrose agar medium and promptly renewed if there is evidence of contamination. The cultures may be kept for not more than 4 months in a refrigerator at approximately 3° to 10° C. Subcultures incubated at 28° to 30° C for 10 to 14 days shall be used in preparing the inoculum.

4.6.2.15.11 Aspergillus Niger, Nutrient Culture Medium, Tests. This test shall be performed in accordance with the procedure specified in 4.6.2.15.1, except for the culture medium, marking of test specimens, controls, and results.

a. Culture Medium. The culture medium used in this test shall have the same composition as that specified in 4.6.2.16.1, with the exception that 30 gm of sucrose shall be added to the other ingredients.

b. Marking of Test Specimens. Guide lines shall be drawn on one side of each specimen with contracting colored waterproof ink 1/8 inch from each edge of the specimen.

c. Controls. Three Petri dishes containing only the solidifed agar medium specified in "a," shall be inoculated with the test organism to determine the visibility of inoculum. At tne end of the inoculation period, the controls shall be well covered with the fungus growth.

d. Results. Upon completion of the incubation period, the specimens shall be examined microscopically (approximately 18X magnification). The hose shall be considered to have failed to meet the requirements of this purchase description if there is any evidence of fungus growth within the area bounded by the guidelines on the specimen square. Growth on the specimen up to but not crossing the guidelines shall be disregarded.

4.6.2.16 Extraction Tests. The extraction tests shall be in accordance with method 6511, of Standard, FED-STD-601. The immersion fluid shall be of Medium No. 5 as specified in FED-STD-601, method 6001.

5.1 Service Life. The hose assembly shall have a minimum service life of 6 months under the following environmental conditions:

a. Loads imposed by a 3-knot cross current and 2- to 4-foot breakers.

b. Exposure of cover of hose to atmospheric conditions and sea water environment with the interior of hose protected with end caps.

c. Exposure to spilled fuels containing up to 40 percent aromatics.

d. Operational exposure from 0° F to 125° F ambient temperatures.

e. Resistant to abrasions from marine terrain suitable for amphibious landings with appropriate surf-zone auxiliary protection.

NOTE:

Part of the demonstration that the test hose is compatible with service life requirements will be a 300-hour flow test at 1000 gpm of test fuel containing up to 40 percent aromatics with the hose floating in a body of water under internal pressure of 100 psig. This test is to be conducted by USAERDL, Fort Belvoir, Virginia. The hose shall show no deleterious effects from this test.

5.2 Storage Life. The hose assembly shall have a minimum storage life of 3 years at ambient temperatures of -25° F through $+125^{\circ}$ F.

Storage life as defined herein, shall mean shelf life in environments with protection provided from sunlight or artificial light containing ultraviolet rays, from oxygen and ozone through use of hose end caps from contact with corrosive and abrasive agents.

APPENDIX C

PURCHASE DESCRIPTION FOR FLOATING-HOSELINE SYSTEM

1 March 1962

1. General. The USAERDL has been directed by the Office, Chief of Engineers, to develop equipment and techniques for the rapid offloading of bulk fuel from barges, tankers, and other craft in support of amphibious assault landings and other combat operations. Current doctrine dictates that the assault elements will carry ashore a 3-day supply of fuel. Based on this doctrine it will be necessary to have fuel ashore in sufficient quantities to effect resupply of these elements by D + 2. These Laboratories consider that the most practical way of bringing fuel ashore during the assault phase is by the use of large-diameter floating hoselines. The hoselines will be replaced by submarine pipelines during the later phases of the operation. It is also contemplated to use these hoselines in operations where it is impossible or impractical to use the submarine pipeline.

It is believed that the majority of the fuel will be delivered by the standard TC 4160-bbl liquid cargo barge. However, some fuel may be brought in by converted LCU or LST.

The system will be installed and operated by personnel of the Engineer Amphibious Support Command (EASC) during the assault phases of the operation and by the Quartermaster Petroleum Depot Company during later phases of the operation.

2. Proposed Concept of Operation (General). As soon as the beach area has been sufficiently organized, the initial unloading of supplies to support the assault force is begun. The beach support area supply points are set up and operated by elements of the EASC shore party. As the supplies are brought ashore, they are separated into the proper supply points for transportation to the tactical units. It is contemplated that major users of Class III (POL) supplies will draw them from the beach support area supply points until the Corps areas are established ashore and forward supply installations are established.

The beach support area supply point for Class III supplies will be comprised of the necessary facilities for the receipt, storage, and distribution of all POL items. It probably will consist of a flexible manifold, up to 1,000 feet long, with a valve every 100 feet, for the receipt of liquid fuels from offshore, collapsible tanks for temporary storage and a means of distributing fuel to the using units. The floating hoseline will be used as a connection between the shore manifold and the offloading vessel. Because of the possibility of small craft damaging the hose, the floating hoseline system may be used only where there is no chance of small boats crossing it. In operation, the hose will be towed from shore to the offloading vessel by a small boat, probably an LCM-8. The hose will be connected to the offloading vessel's manifold and the boat will return to shore straightening and anchoring the hose as it returns. The hose is then connected to the manifold and the vessel may begin offloading. When offloading is complete, the fuel remaining in the hose is evacuated and the hose is retrieved.

3. Proposed Method of Operation (Detailed).

a. Installation. After the vessel to be offloaded is moored in the offloading area (denoted by flags) the hose will be brought out to the vessel by a work boat (LCM-8) and attached to the discharge manifold. As the hose is being installed, the tension relief cable and marker buoys are attached. This cable is attached to a bitt on the offloading vessel and anchored to a deadman on shore. Its purpose is to relieve the stress in the hose caused by current and wave action. As the work boat returns to shore, the crew straightens any bow in the line and installs an anchor every 100 feet. As the line is being straightened, the slack is taken up on shore, to keep the cable taut. When the anchors have been set and the hose secured, it is connected to the shore manifold and the unloading operation begun. Where there is considerable distance between shore and the offloading vessel, a second boat may be needed to straighten the line and set the anchors as the hose is being installed.

b. Evacuation. After offloading is complete, it is necessary to evacuate all fuel from the hose before it may be retrieved. It is believed that this may best be accomplished by forcing a spherical rubber ball through the hose with compressed air either from shore or from the vessel. It is preferable to evacuate from the vessel towards shore, to force all fuel into storage on shore. A fitting to inject the ball into the hose and another to prevent it from being forced into the shore manifold must be installed in the line before evacuation may begin. These fittings should be installed when the line is installed. The compressed air may be supplied either from air bottles or a compressor carried on the support vessel or by air hose from a compressor on shore. After the inlet and receiver fittings are in place, the air is admitted behind the ball and the ball pushed through the hose forcing the fuel ahead of it. When all fuel is evacuated, the fittings and ball are removed from the hose and it is ready for recovery.

c. Recovery. During the recovery phase, the anchors are detached from the hose beginning at shore and working toward the offloaded vessel. When all anchors have been removed, the cable and hose are detached from the vessel and the hose and cable rewound on the reel. The cable and floats are removed from the hose prior to rewinding.

4. Hoseline System Components. The hoseline system will consist of 500 feet of 8-inch floating hose in one 300- and two 100-foot lengths, a tension relief cable, a reel suitable for mooring and installing and retrieving the hose and cable, and the necessary

anchors and floats to install the system. In addition, equipment to supply a 4 point mooring for the offloading vessel will be required, sea and shore markers to designate the offloading area, equipment to secure the cable to the shore and to the vessel, equipment to protect the hose from abrasion where it passes through the surf zone and over the side of the vessel and the tools, equipment, and spare parts necessary to maintain the system.

Pumps will not be required as the offloading vessels are expected to have their own pumping equipment.

5. Technical Requirements.

a. Hose. The hose shall conform to the requirements of the Annex to this Purchase Description entitled "Floating Hose Assemblies, Rubber: Petroleum Discharge Service Only." Each floating hoseline system shall consist of one 300-foot and two 100-foot lengths of hose. The hose shall have sufficient tensile strength to withstand the stresses caused by current and wave action. A rubber or plastic sleeve with a cargo hook shall be installed every 50 feet between couplings for attaching the hose to the tension relief cable. The hose shall be free to rotate within the sleeves.

b. Tension Relief Cable. The tension relief cable shall have sufficient strength to withstand the forces incurred when the system is installed in a 3-knot cross current. A "D" ring shall be attached every 49 feet for securing the hose and anchors to the cables. The tension relief cable shall have suitable fittings on both ends for securing it to the vessel and to anchors or deadmen on shore. The cable shall have an abrasion-resistant plastic or rubber covering, to prevent the cable from chaffing the hose and protect the crew during installation.

c. Reel. The reel shall be designed so that the hose may be stored, transported, and distributed from the reel. The reel shall be fabricated from lightweight, corrosion-resistant material with the center of gravity as low as possible. The drums shall be equipped with a manual brake to control the drum speed and a suitable rewind device, either manual or motor-operated. The rewind speed shall not exceed 6 RPM. A separate drum shall be provided for the tension relief cable.

d. Anchors. Anchors shall be provided for holding the hose on range and for providing mooring anchors for the offloading vessel. Anchors shall be of the Navy lightweight type. Hoseline anchor assemblies shall consist of a 50-pound LWT anchor with 50 feet of 3/8-inch chain and a marker buoy. Mooring anchors shall weigh 100 pounds and shall have 75 feet of 1/2-inch chain. Five anchor assemblies shall be provided for the hose and four anchor assemblies for the vessel. In addition, suitable anchors or deadmen shall be provided to secure the tension relief cable on shore.

e. Marker Buoys and Range Markers. Marker buoys shall be inflatable floats. The buoys shall be colored International Orange for visibility. A buoy shall be permanently attached to each hose anchor chain. Hoseline marker buoys shall have a swivel "D" ring for attachment to the cargo hook of the hose.

Range markers shall be flags colored International Orange. Flags shall be not less than 2 feet square. Markers shall be furnished with suitable standards. Sea range markers may be mounted on an anchored buoy rather than on a standard. In addition, shore markers shall have a marker designating a POL storage area. This marker shall be a yellow funnel on a black background. The marker shall be not less than 2 feet square.

f. Spare Parts. The following spare parts shall be furnished with each system:

Hoseline Anchor Assemblies	–	5
Vessel Anchor Assemblies	–	4
Grooved Couplings	–	5
Cable Clips and "D" Rings	–	15

g. Miscellaneous Items. In addition to the above, various other items will be required to support the system. Among these items are:

(1) Reducing Adapters, Grooved-type – 10-inch by 8-inch, 8-inch by 6-inch, and 8-inch by 4-inch - 2 each.

(2) 150 #ASA STD Flange to grooved adaptors

4-, 6-, 10-inch	–	2 each
8-inch	–	4 each

(3) Tool and repair kit for hose – 1 each

Contents to be determined by contractor: All necessary tools for installation, etc., and material for 10 hose repairs shall be included. It is contemplated that repair will be made using nipples similar to the end nipples.

(4) A sling or cradle to protect the hose where it crosses the side of the offloading vessel will be required.

The engineering tests may indicate that other items will be required for the proper installation, operation, recovery, and maintenance of the system. These items shall be included as required.

6. Installation and Operating Requirements. The system shall be capable of being installed on any beach suitable for and under conditions permitting an amphibious landing. In general, this will entail moderate surf conditions (2- to 4-foot breakers) and a 3-knot cross current. The system shall be capable of operating in the ambient temperatures of 0° F to $+125^{\circ}$ F.

It is believed that the 500 feet of hose in one system will be sufficient in the majority of operations; however, the system must be capable of being expanded to 1,000 feet if the circumstances require.

7. Storage and Service Life. The hoseline system shall have a minimum storage life of 3 years and a minimum service life of 6 months, after which it shall be considered expendable. If necessary to secure the required service life, the contractor shall develop a method to protect the hose in the surf zone. Storage shall be under cover with ambient temperatures of from -25° F to $+125^{\circ}$ F.

ANNEX TO APPENDIX C

PURCHASE DESCRIPTION FOR
FLOATING HOSE ASSEMBLIES, RUBBER:
PETROLEUM DISCHARGE SERVICE ONLY

1. SCOPE.

1.1 This purchase description covers rubber hose assemblies for petroleum discharge, used as a component of a floating hoseline tanker unloading system.

2. APPLICABLE DOCUMENTS

2.1 The following documents form a part of this purchase description to the extent specified herein.

SPECIFICATIONS

Military

MIL-G-3056 – Gasoline, Automotive, Combat.

MIL-P-3136 – Standard Test Fluids; Hydrocarbon.

MIL-G-5572 – Gasoline, Aviation: Grades 80/87, 91/96, 100/130, 115/145.

MIL-J-5624 – Jet Fuel, Grades JP-3, JP-4, and JP-5.

STANDARDS

Federal

Federal Test Method
STD. No. 601-Rubber: Sampling and Testing.

Military

MIL-STD-129 – Marking for Shipment and Storage.

MIL-STD-130 – Identification Marking of U. S. Military Property.

(Copies of specifications and standards required by contractors in connection with specific procurement function should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Description. Each hose assembly shall consist of a reinforced synthetic rubber hose, furnished with grooved-type end nipples, a grooved-type coupling, and a grooved-type cap.

3.2 Evaluation length. The evaluation length is defined as a hose assembly which is identical to the hose assemblies which the manufacturer will subsequently produce in fulfillment of the contract. The contractors examination and tests shall be those specified herein.

3.3 Material. Material shall be as specified herein. Materials not specified shall be selected by the contractor and shall conform to all the provisions of this purchase description.

3.4 Hose. The hose shall consist of an inner tube, two or more plies of reinforcement material, and a protective cover, bonded to each other and vulcanized to produce a united hose wall. The hose assemblies shall have an 8-inch nominal inside diameter and shall weigh not more than 6 pounds per foot.

The length of the hose assemblies shall be as specified. The measured length shall be from the extreme ends of the hose nipples.

3.4.1 Inner Tube. The rubber inner tube shall be of homogeneous composition, free from extraneous inclusions, and uniform in thickness. The interior surface shall be smooth and free from pitting, and shall be clean of all foreign materials and mandrel lubricants. The tube shall not be affected by prolonged exposure to aromatic hydrocarbon fuels and shall not affect the quality of these fuels. The fuels shall be engine and aircraft fuels conforming to Specifications MIL-G-3056, MIL-G-5572, and MIL-J-5624.

3.4.2 Reinforcement material. The reinforcement material shall be evenly and firmly fabricated and shall be free from dirt, knots, lumps, irregularities of twist, or other defects which may impair the serviceability of the hose. The reinforcement material shall be uniformly distributed throughout the full length of the hose and shall not be exposed at any place on the hose.

3.4.3 Cover. The protective cover shall be fully resistant to hydrocarbon fuels, sea water, ozone weathering, abrasion, and marine growths. The cover shall be uniform in thickness; smooth; and free from slits, cracks, or holes. Vulcanization shall not be permitted when repairing. The ends of the cover shall extend over and be vulcanized to the ends of the inner tube and the reinforcement material.

3.5 End Nipples. End nipples shall be fabricated from an aluminum alloy resistant to the corrosive effects of immersion in sea water. A suggested form for the end nipple is shown in Fig. 27. Each nipple shall be equipped with a Figure-8 ring for attaching the tension relief cable. The ring shall be free to swivel around the nipple. Safety cargo hooks shall be attached to each Figure-8 ring with a swivel attachment. End nipples shall be attached to the hose by not less than 3 double wraps of stainless steel banding.

3.6 Coupling. One 8-inch aluminum coupling conforming to Military Specification MIL-G-10387. Couplings shall be furnished with cadmium-plated steel bolts and gaskets.

3.7 Protective Caps. Protective caps shall conform to Military Specification MIL-P-10388. Each cap shall be provided with a ring for towing the hose. Caps shall be fabricated from an aluminum alloy.

3.8 Dimensional Changes and Tolerances.

3.8.1 Diameter. Diameter tolerance shall be plus or minus 1/8 inch. When the assembly is subjected to an internal pressure of 100 psi, the change in diameter shall be not more than 10 percent of the original outside diameter.

3.8.2 Length. Length tolerance shall be plus or minus 2 percent. When the assembly is subjected to an internal pressure of 100 psi, the change in length of the assembly shall be not more than ± 5 percent of the measured length.

3.8.3 Twist. The free hose shall not develop a twist exceeding 30° per 100-foot lengths when subjected to the design operating pressure of 100 psi.

3.9 Intermediate Connections. Each hose assembly shall be equipped with a plastic or rubber sleeve every 50 feet. Each sleeve shall have a safety cargo hook for attaching the hose to the cable. The sleeve shall be free to rotate around the hose.

3.10 Performance.

3.10.1 Operating Temperature Requirements. The hose assemblies shall perform as specified herein at any ambient temperature from plus 125° F to 0° F.

3.10.2 Flotation. The hose assembly shall float in 62.4 pounds per cubic foot of water at a temperature of 35° to 40° F when filled with 0.85 specific gravity fuel.

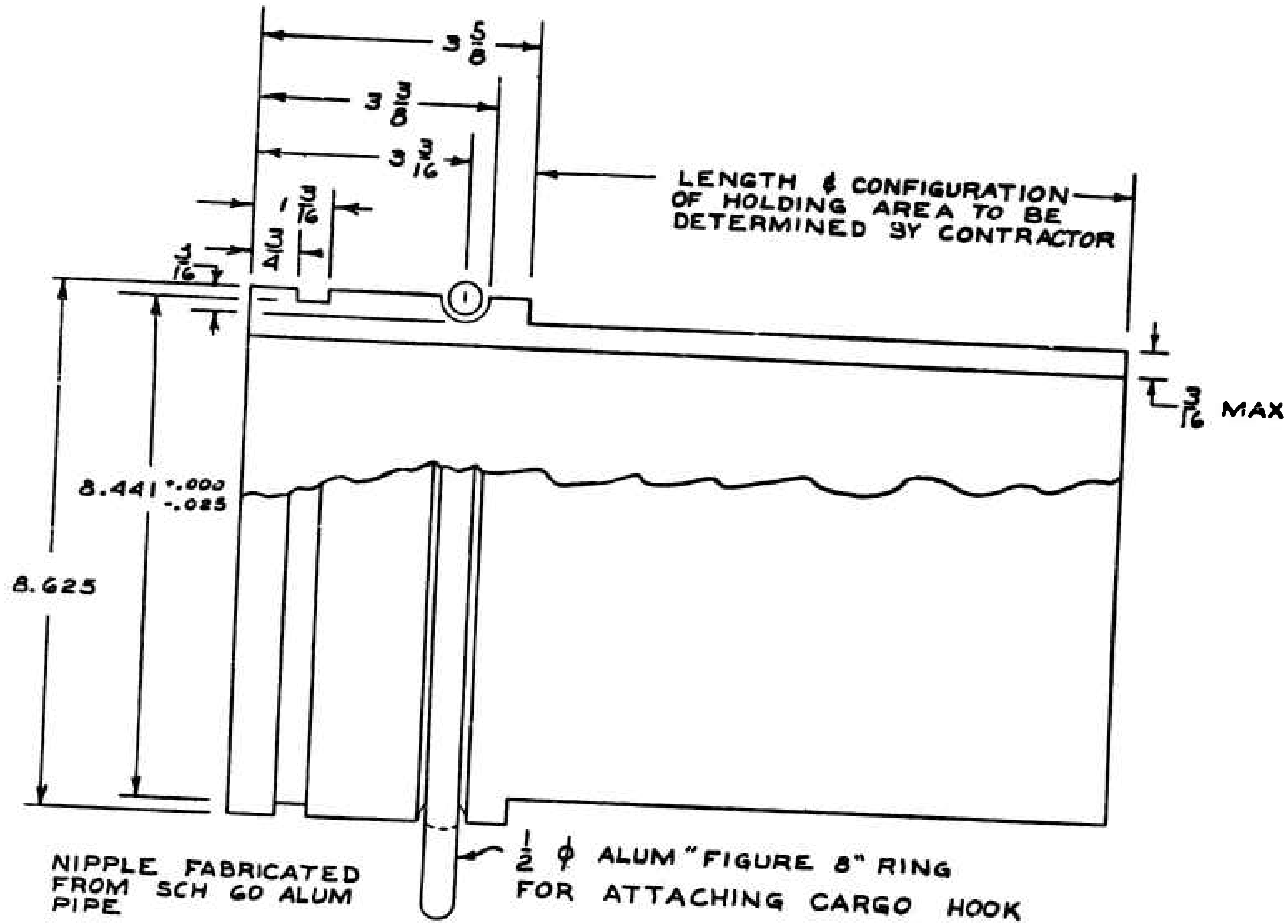

Fig. 27. Suggested form for hose nipple.

3.11 Physical Properties.

3.11.1 Friction. The friction between component parts of the hose shall not be less than 10 psi, prior to exposure to fuel, and not less than 6 psi, after exposure to fuel. Friction is the term used to denote the adhesion between component parts.

3.11.2 Tensile strength. The tensile strength of the inner tube and cover before exposure to fuel shall be not less than 900 and 800 psi, respectively. After exposure to fuel, the tensile strength shall be not less than 600 and 500 psi, respectively.

3.11.3 Ultimate elongation. The ultimate elongation of the tube cover before exposure to fuel shall be not less than 250 percent. After exposure to fuel, the ultimate elongation shall be not less than 150 percent.

3.11.4 Volume increase. The volume increase of the tube and cover, after exposure to fuel, shall be not more than 40 and 100 percent, respectively.

3.12 Proof pressure resistance. The hose assembly shall not seep, spray, split, or show any evidence of failure when subjected to a hydrostatic pressure of 200 psi.

3.13 Burst pressure resistance. The hose assembly shall not seep, spray, split, or show any evidence of failure when subjected to a hydrostatic pressure of 350 psi.

3.14 Identification marking. Each hose assembly shall be identified in accordance with standard MIL-STD-130. Identification shall be affixed approximately 3 feet from each end of the hose assembly.

3.14.1 Additional marking. Each hose assembly shall have a 2-inch wide yellow stripe, on the outside, parallel to the bore to indicate the natural lay of the hose.

4. QUALITY ASSURANCE PROVISIONS

4.1 Classification of Inspection. Inspection shall be classified as follows:

(a) Evaluation inspection of the hose assembly.

(b) Production inspection of the hose assembly.

4.2 Inspection.

4.2.1 Examination. The hose assembly shall be subjected to the examination specified in Table III.

Table III. Hose Assembly Inspection Schedule*

Inspection Sequence	Type of Inspection: Evaluation	Production: Individual	Production: Sample	Examination or Test	Inspection Paragraphs	Standard Test Paragraphs	Requirement Paragraphs
1	X	X		Examination	4.4.1		3.1 thru 3.7 and 3.9
2	X		X	Operating temperature	4.4.2.1		3.10.1
3	X		X	Diameter expansion	4.4.2.2	2231 or 2351	3.8.1
4	X		X	Elongation of length	4.4.2.3	2411	3.8.2
5	X			Flotation	4.4.2.4		3.10.2
6	X	X		Proof pressure resistance	4.4.2.9	10211	3.12
7	X		X	Twist	4.4.2.11		3.8.3
8	X		X	Burst pressure resistance	4.4.2.10	10011	3.13
9	X			Friction	4.4.2.5	8011	3.11.1
10	X			Tensile strength	4.4.2.6	4111	3.11.2
11	X			Ultimate elongation	4.4.2.7	4121	3.11.3
12	X			Volume increase	4.4.2.8	6211	3.11.4

*Perform inspection marked "X"

4.2.2 Sampling. Sampling for tests shall be a hose assembly selected at random for each lot of 100 hose assemblies, or less, representing hose of the same size. The sample shall be in addition to the quantity required for delivery.

4.2.3 Tests. The hose assembly shall be subjected to the tests specified in Table III.

4.2.3.1 Individual tests. Each hose assembly shall be subjected to the tests specified in Table III.

4.2.3.2 Sample tests. Samples selected in accordance with 4.2.2 shall be subjected to the tests specified in Table III.

4.3 Inspection schedule. Inspection schedule shall be as shown in Table III. All test methods shall be in accordance with Standard Federal Test Method STD. No. 601.

4.4 Inspection procedure.

4.4.1 Examination. The hose assembly shall be visually examined for overall conformance with the requirements of this Purchase Description.

4.4.2 Tests.

4.4.2.1 Operating temperature. Wind hose on a drum having a diameter of 2 feet 8 inches. Condition the hose in temperature of 0° F plus or minus 2° for a period of 24 hours. At end of conditioning period straighten the hose manually while maintaining the specified temperature. Cracking, splitting, or any evidence of failure in the hose shall constitute failure of this test.

4.4.2.2 Diameter expansion. The basic diameter of the hose shall be established with the hose under an internal pressure of not more than 10 psi. With the hose subjected to an internal pressure of 100 psi, measure the expansion in the diameter in accordance with Method 2231 and 2351. Contraction or expansion of more than 10 percent of the basic outside diameter shall constitute failure of this test.

4.4.2.3 Elongation of length. The basic length of the hose shall be established in accordance with Method 2411. Subject the hose assembly to an internal pressure of 100 psi and remeasure the overall length of the hose. Elongation of the length of the hose to more than minus 5 or plus 5 percent of the basic hose length shall constitute failure of this test.

4.4.2.4 Flotation. Fill the hose assembly with a 0.85 specific gravity fluid under a pressure of 10 psi with both ends capped. Place the hose assembly in a body of water having a density of 62.4 pounds per cubic foot and a depth in which the hose will float. Failure of the hose length to remain visible on the surface shall constitute failure of this test.

4.4.2.5 Friction. Friction between component parts (layers) of the hose shall be tested in accordance with Method 8011. This test shall be conducted to samples both before and after exposure to fuel. Friction in the sample prior to exposure of less than 10 psi and after exposure of less than 6 psi shall constitute failure of these tests.

4.4.2.6 Tensile Strength. The tensile strength of the inner tube and the cover shall be tested in accordance with Method 4111. Tests shall be conducted to samples both before and after exposure to fuel. Tensile strength of the inner tube and cover, prior to exposure to fuel, of less than 900 and 800 psi, respectively, and tensile strength of the inner tube and cover after exposure to fuel, of less than 600 and 500 psi, respectively, shall constitute failure of these tests.

4.4.2.7 Ultimate Elongation. The ultimate elongation of the inner tube and cover shall be tested in accordance with Method 4121. The tests shall be conducted to samples both before and after exposure to fuel. An ultimate elongation of the inner tube and cover, prior to exposure to fuel, of less than 250 percent, and an ultimate elongation of the inner tube and cover, after exposure of fuel, of less than 150 percent shall constitute failure of these tests.

4.2.2.8 Volume Increase. The volume increase in the tube and cover after exposure to fuel shall be tested in accordance with Method 6211. A volume increase in the tube and cover of more than 40 and 100 percent, respectively, shall constitute failure of these tests.

4.4.2.9 Proof Pressure Resistance. Each hose assembly shall be tested for proof pressure resistance in accordance with Method 10211 and as follows:

The hydrostatic pressure shall be raised slowly to 200 psi and held for a period of 30 minutes. The pressure shall then be reduced to 0-5 psi and held for a period of 1 minute. This cycle shall be repeated 25 times. Seepage, evidenced by surface wetting, spraying, splitting, or any evidence of failure in the hose assembly shall constitute failure of this test.

4.4.2.10 Burst Pressure Resistance. The 5-foot hose assembly shall be tested for burst pressure resistance in accordance with Method 10011. Any evidence of failure, seeping, spraying, or splitting shall constitute failure of this test.

4.4.2.11 Twist. A collar shall be installed on a free end of the sample hose during the proof pressure test. The hose free end shall rotate freely within the collar, which shall be stationary with respect to the hose. A line will be marked with a crayon or soft pencil on the top surface of the collar aligned with the center of the hose yellow line. The displacement between these lines at 100 psi pressure will be used for calculation of the amount of twist. The twist exceeding 30° per 100 feet of length shall constitute failure of these tests.